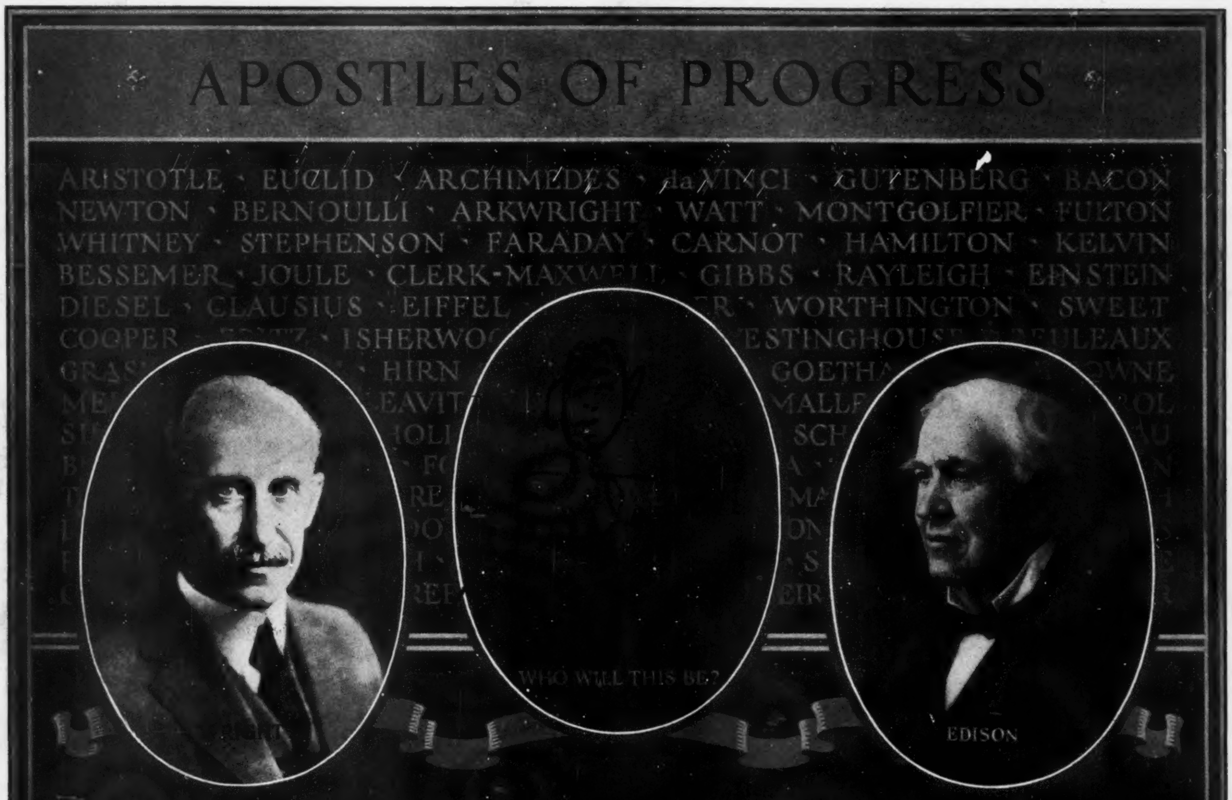
IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING



IN 1881, R. H. Thurston, first president, A.S.M.E., said that the world was waiting for three great inventors: he who would discover the source of light of the firefly; he who would learn the secret of flight; and he who would show how to produce electricity directly from coal. Edison has given us inexpensive, abundant light, although not from the firefly source. Wright has taught us to fly. The third inventor is unknown. Behind these men lie the developments of former centuries. There are still opportunities for progress.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

January 1930

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In pulverized fuel firing, uniform fineness is required for uniform furnace conditions.

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The Lopulco air swept classifier is a positive assurance of properly sized coal as only the finer particles CAN leave the classifier—the coarser coal is automatically returned to the mill for further grinding. Each particle must meet the standard of fineness for which the system is set. This classification is simple, positive and automatic and is independent of the wear on the hammers. Incidentally, the Lopulco classifier is a patented feature and is available only on Lopulco pulverizers.

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Mechanical Engineering

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CONTENTS OF THIS ISSUE

DEPARTMENTAL

ADVERTISING

Section Two—News of Mechanical Engineering

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To New A.S.M.E. Members

LIFE in all lands and in all walks is being speeded up, made more productive, richer, and happier. Barriers of race, language, distance, and ancient prejudice, which kept peoples antagonized and apart, are being swept away and replaced by ties of mutual interest in the welfare of each other.

The influence that is speeding up and enriching the processes of social and commercial life is power, and the influence that is breaking down the ancient barriers of antagonism is communication, and back of power and of communication is the engineer—that great cosmopolitan whose purview comprises the whole human race and whose ambition it is to serve all. This aspiration he can realize, not by his individual efforts alone, but only as he bases his work on the achievements of those who have gone before and weaves it in with that of his contemporaries.

Out of this interdependence and community of interests grows a fraternal feeling among all of the profession, of all callings, and of all nationalities. It is this that brings them together in such societies as ours, and leads them to disclose, for the benefit of all, their discoveries, achievements, and failures.

The interest of engineers in each other at all times is even more cordial in welcoming a newcomer into that fraternal relationship, and this is why we pause in our festivities on these occasions to extend to you the hand of fellowship, asking in return only that you live the traditions of your new association, honor and be an honor to the profession, and in your turn be kindly and helpful to the young engineer who approaches you.

"One for all and all for one" might well be an engineer's slogan, except for the inference of a defensive bund against a common enemy. With us there is no common enemy except Nature's secrets to be exposed and Nature's obstacles to be overcome.

Instead of the motto of the Musketeers, as our greeting to you I prefer the simple and sincere welcome that appears above the fireplace of an engineers' club in a distant city:

"Men our brothers, men the builders,
Come you from afar or near,
Welcome to our home and fireside,
Welcome, brother Engineer."

W. L. ABBOTT.

(From charge to new members at the Annual Dinner of the A.S.M.E., New York, December 4, 1929.)

MECHANICAL ENGINEERING

Volume 52 January, 1930 No. 1

Engineering Education—A Layman's View

By JAMES ROWLAND ANGELL,[1] LL.D., NEW HAVEN, CONN.

PERHAPS you will allow me to speak very briefly about some educational aspects of engineering which interest the layman. Those of us who have watched from the outside have been much struck by the change which has come over the engineering profession in the last generation or two. A very large majority of the members of a group of this kind were formerly recruited from men who had come up through the factories, through the industries, through field work, through practical work in the mines or elsewhere, and not through the engineering schools. At present, I fancy the proportion is quite the other way, and rather heavily, and in the measure in which that is true, I take it that increasingly the procedure in the engineering schools has practical significance for the profession.

Engineering has made a very critical and objective study of its own educational procedure; in fact, probably the most thorough that has been undertaken by any important profession, and I have no doubt that it will be extremely productive in the practical results which flow from it, after all its implications are digested and put into practice. It may therefore be thought unbecoming for the layman to venture any comments. Be that as it may, we on the outside have been interested to see that in recent years there has been very large abandonment of the stress on purely manual skills. In place of it has come an increasing emphasis on what are broadly called the humanistic interests of education, with a good deal of accent on economics and on accountancy, and with some regard also to history. The effort is even made to teach young men how to write English, which seems to be a lost art in many branches of the profession. These things, I say, we have observed with very great interest, and not less the effort to give some knowledge of the great problems of management not only in the large sense of the business and administrative organization of industry, but also more intimately on the personnel side. We have noted these changes with real sympathy, because they have seemed to us to be keyed to what I take to be the fundamental American conception of engineering as an art concerned with the basic interests of mankind.

A satisfactory engineering education must accordingly magnify in all its branches the importance of human welfare and an understanding of the personal, social, and economic factors on which it depends.

I CONGRATULATE you more than I can readily say on the indispensable part which you play in all our national contemporary interests, and on the part which you have an opportunity to play in the great America that is coming tomorrow. It is of course in a sense a great mechanical America. That is a truism which is always being sounded in our ears; but so long as we have men in control of our engineering profession as we have today, who conceive it not as a purely mechanical thing, but as a humanistic enterprise, who think of it in terms of human service, as you men do, we need never fear for our national destiny. To confuse materialism with the exploitation of material resources, without regard to the purposes to which they are put, is to make one of the most fundamental intellectual blunders that stupidity can coin. The ideals which inform your profession are sound and fine, and worthy of the emulation of all of us.

Engineering Graduates Criticized as Not Being Fundamentally Sound Scientists

Of course we hear critical voices raised now and then. It is always the open season for abusing education from the college down. The criticism which I hear most often at the present time from the outside, and to some extent from the engineering profession itself, is that our engineering schools are not training men who are, as such, fundamentally sound scientists. Young graduates may be alert young fellows, they may have fairly good elementary training in this direction or that, but in general it is alleged that they are not satisfactorily trained in fundamental science, including mathematics. If the engineering school admits any justice in the criticism, it is apt to pass back responsibility for the condition to the poor training given by the preparatory school.

As bearing on the same alleged defect, the critical point to the absence of research interests in the engineering schools, a criticism which perhaps would have been valid a few years ago, but which certainly is very inapplicable to many of our engineering schools at the present time. Even so, I think our engineering-school faculties are all agreed that they are confronted with a very grave difficulty in attempting in the period of time at their disposal and in the face of the kind of training which their students bring in chemistry, physics, and mathematics, in really turning out the type of engineer they would like. Naturally they are all agreed also that if they could have more time they could certainly do a better job. But the efforts to introduce

[1] President, Yale University.

Address delivered at the Annual Dinner of The American Society of Mechanical Engineers, New York, December 4, 1929.

a five- or six-year course have for the most part not turned out very well. At least, they have not been generally accepted by the student public that the schools serve.

To compare to his disadvantage the young boy who comes out with a B.S. degree from an engineering school with a man who has just taken his doctor's degree in chemistry or physics, as certain of the industrialist critics of engineering schools appear at times to do, is of course utterly unfair. To be sure, if the latter is the kind of man industry wants and the engineering profession as a whole wants, it obviously behooves us to study the question further and ascertain whether there are methods by which we can more closely approximate what our generation requires. But as an outsider I feel sure that such a demand reflects only a part of the situation. There are certain possible remedies which perhaps touch only the periphery of the problem, but which nevertheless are very significant. They concern matters to which I feel sure you gentlemen in the active profession should give thoughtful consideration.

Recruitment of Strong Men Urgent for the Teaching Profession

Most important of all is the recruitment of strong men for the teaching profession. I do not see how, by any kind of reorganization of our engineering education, we can hope to achieve the degree of success which we should like uniformly to attain, unless we are able to obtain in the teaching positions of our engineering schools a larger proportion than at present is possible of the ablest brains in the engineering profession.

As a matter of fact, in the past we have fortunately been able to secure a very remarkable amount of those best brains for reasons I needn't go into. But when we have to compete with the great industries, with the opportunities which the profession outside the industries holds out to progressive and aggressive, able men, opportunities not only of a financial character, but opportunities of the sort that inspire the imagination and touch the ambition of any man who likes to tackle a big job and do it successfully—as long as these conditions obtain, and particularly when the financial rewards are as great as they are at present, the engineering schools are going to have a hard time commanding a reasonable number of first-class men for their faculties; and unless they secure such men, I doubt whether they will ever turn out graduates that the profession in general will regard as satisfactory.

Engineering-School Faculties Should Include Representatives of the Ablest Brains in the Profession

Speaking frankly, albeit with complete deference, I think you gentlemen have a very great obligation toward engineering education to see to it that by one device or another you make it possible in far larger degree than is now the case, for the engineering schools to secure and retain representatives of the ablest brains in the profession. There are many ways no doubt in which you can do this. But the obvious is to establish by endowment chairs in the schools that will attract men of the highest character, giving them not only adequate financial rewards, but also opportunities for research and for study—the financial backing and the opportunities which that brings with it, to carry on inside the educational organization the kind of work which is so inspiring and so rewarding to the man who is in the important position outside.

I had some other things on my mind to say, but I have already taken more of your time than is considerate, and the points upon which I have touched are really the cardinal issues. They concern the giving to the engineering schools of the resources which they need in men and financial backing to do a first-class job—and that cannot be done, no matter what your pedagogical procedure or your secondary education, until you have first-class men in large numbers, and the resources to let them work under the best conditions.

Will you let me say, before I take my seat, how very greatly, as a layman, and also as a man in educational work, I appreciate the significance of your profession, not only in our modern life in general, but also in its special implication for education? It constantly challenges those of us who are in educational work to examine the reality of our undertakings. It gives us a constant contact of the most practical sort with interests that lie at the very heart of our community life, that are, indeed, the keynotes of our civilization. It is an inspiration to work side by side with men who are engaged in such work. It is an invaluable incentive to the rest of us to keep our feet on the ground and see things as they are.

The Indispensable Part Played by Engineers in National Contemporary Interests

I congratulate you more than I can readily say on the indispensable part which you play in all our national contemporary interests, and on the part which you have an opportunity to play in the great America that is coming tomorrow. It is of course in a sense a great mechanical America. That is a truism which is always being sounded in our ears; but so long as we have men in control of our engineering profession as we have today, who conceive it not as a purely mechanical thing, but as a humanistic enterprise, who think of it in terms of human service, as you men do, we need never fear for our national destiny. To confuse materialism with the exploitation of material resources, without regard to the purposes to which they are put, is to make one of the most fundamental intellectual blunders that stupidity can coin. The ideals which at present inform your profession are sound and fine, and worthy of the emulation of all of us.

Outwitting Obsolescence

When is a machine obsolete? Answer: On the day the market offers another machine whose additional effectiveness will justify the cost of junking the old for the sake of the new. This, in extreme cases, may happen in the first year of a machine's life. Or, at the other extreme, it may run for twenty or thirty years and wear itself out before it is overtaken by obsolescence. On the average, power equipment becomes obsolete in ten or fifteen years.

Obsolescence, like death, is a condition that cannot be remedied after it arrives. If a machine is obsolete, that is the end of the matter as far as economic operation is concerned. But forethought may often defer obsolescence, just as it prolongs human life.

In the case of machines this foresight must be applied when the purchase is made. Yet that is just the time when the ultra-conservative buyer is likely to defeat his own aim of "safety first" by demanding equipment with a long record of reliable service. He says "this is the engine or boiler for me. For ten years (or twenty or thirty), without change in design, it has 'delivered the goods.'" Such a purchase surely insures the buyer against mechanical or operating defects, but he pays for this certainty even though the price may seem reasonable enough. Ten years on the market without design changes means nine years' handicap in the obsolescence race with his competitor who is satisfied with a machine that has proved itself in operation for one year. It takes better judgment to evaluate the new, but those who have this judgment, and apply it, gain a tremendous advantage by adding a known period of five or ten years to the unknown total span of economic life.—*Power*, Dec. 3, 1929, p. 875.

Progress and Prospects in the Field of Mechanical Engineering

A Review of Recent Accomplishment in Its Various Branches, Prepared by the Professional Divisions of The American Society of Mechanical Engineers

FOREWORD

ROBERT HENRY THURSTON, first President of the Society, in his inaugural address fifty years ago, pictured the state of mechanical engineering and industry. The following year, 1881, in his presidential address entitled "Our Progress in Mechanical Engineering," he reviewed the developments in these same fields. Throughout the history of the Society others have from time to time pictured progress and trends. In late years the Professional Divisions of the Society have undertaken the task of preparing Reports of Progress in the various fields their activities represent, thus making an extensive annual feature of what was originally an occasional limited survey.

These yearly reviews by the Professional Divisions have become not only a prominent feature of the Society's publications, but of the Annual Meeting of the Society as well. Prepared by committees of experts whose professional work lies in these fields, they form a historical record of the significant events of the year. More than this, they point the pathway toward tomorrow, exhibiting as they do the trends in the immediate future development of numerous branches of mechanical engineering.

Condensed in these brief summaries are the fruits of a year's endeavor in mechanical engineering. No man can hope to keep posted in all of these fields without extensive reading and wide and unusual experience. But every member of the Society, and every one interested in the development of industry and mechanical engineering, will find these reviews of progress a source of valuable and interesting information that is timely and authoritative. Thus will every one find an opportunity of bringing himself once more abreast with the times.

To the committees of the Divisions who have prepared these reports, to those who have contributed facts and comment, to those who have selected the material and put it in form for publication, the Society and the engineering profession owe a debt which is hereby gratefully acknowledged.

Elmer A. Sperry,
President, A.S.M.E., 1929

Progress in Aeronautics

Contributed by the Aeronautic Division

Executive Committee: Edwin E. Aldrin, *Chairman,* Alexander Klemin, *Secretary,* Elmer A. Sperry, Wm. F. Durand, Charles H. Colvin, and Thurman H. Bane

Power Plants[1]

AN EXAMINATION of Table 1 indicates that the development of airplane engines during the past year has proceeded apace. The radial air-cooled engine is still the most widely manufactured and used, but it is being pushed in the low-horsepower class by air-cooled in-line engines of various makes.

The development of new engine types is proceeding very slowly. The Packard Diesel made a spectacular non-stop flight from Detroit to Langley Field in May, but since then has been kept well under cover. The Curtiss H-1640 (Chieftain) engine has not yet progressed beyond the development stage. The Wright V-1460, a twelve-cylinder inverted-vee air-cooled engine, is being installed experimentally in some Army Air Corps airplanes.

The Pratt and Whitney R-1340 (Wasp) has progressed to the Series C engine, which is slightly heavier than the series B, but has increased durability. The Pratt and Whitney Hornet has progressed from the R-1690 to an R-1860 (Hornet Series B) engine of 575 hp., which is already in service in both military and commercial airplanes.

The Wright Aeronautical Corporation has brought out the new J-6 (Whirlwind) engines, the R-540, R-760, and R-795. The J-5 has been withdrawn from production and the J-6 engines are being used extensively. The Wright R-1750 (Cyclone) has undergone various improvements. The Wright Company is bringing out an American edition of the De Havilland Gypsy.

The Curtiss Company has installed several of their water-cooled V-1570 (Conqueror) engines in commercial airplanes. The Curtiss R-600 (Challenger) in a Curtiss Robin airplane set up a world record for sustained flight of over 400 hours at Saint Louis. The Curtiss Company has recently produced a small 125-hp. inverted 6-in-line air-cooled Crusader engine.

[1] Prepared by Lieut.-Commdr. James M. Shoemaker, U. S. Navy, Washington, D. C.

TABLE 1 AIRPLANE ENGINES—APPROVED-TYPE CERTIFICATES ISSUED IN 1929 BY THE U. S. DEPARTMENT OF COMMERCE

Key

4—number of cylinders	I—inverted
R—radial (arrangement)	A—air cooled
V—vee	W—water cooled
L—in line	G—gear drive

A.T.C. No.	Date	Description		Rated hp.	Rated r.p.m.
10	10-11-28	Curtiss D-12	12VW	435	2300
11	4-4-29	Dayton Bear	4LA	100	1500
12	11-30-28	LeBlond 60	5RA	65	1950
	1929				
13	1-26	Wright J5 Whirlwind	9RA	220	2000
14	1-22	Pratt & Whitney Wasp	9RA	450	2100
15	12-19-28	Pratt & Whitney Hornet	9RA	525	1900
16	2-5-29	Axelson Axelson	7RA	115	1800
17	1-26	Wright Cyclone R-1750-A	9RA	525	1900
18	1-26	Packard 3A-1500 Direct	12VW	525	2100
19	1-26	Packard 3A-2500 Direct	12VW	800	2000
20	2-6	LeBlond 90	7RA	90	1975
21	2-15	Wright J6 R-975	9RA	300	2000
22	3-11	Arnold Harris	8VW	90	1400
23	3-27	Wright J6 R-540	5RA	165	2000
24	6-3	Alliance Hess Warrior	7RA	115	1925
25	6-8	Michigan Rover	4LAI	55	1900
26	7-9	Wright J6 R-760	7RA	225	2000
27	8-14	Lycoming R-645	9RA	185	2000
28	8-30	Pratt & Whitney Hornet, R-1860 Series B	9RA	575	1950
29	8-30	Pratt & Whitney Hornet, R-1690-A Geared 2:1	9RA	500	1900
30	9-13	American Cirrus Mark III	4LA	90	2100
31	9-23	Aircraft engines LA-1 A.C.E.	7RA	140	1800
32	10-5	Continental A70	7RA	165	2000

One of the outstanding engine developments of the past year was the release, by both the Army Air Corps and the Navy Bureau of Aeronautics, of information regarding the work done on high-temperature cooling of liquid-cooled (hitherto called "water-cooled") engines. The most efficient cooling medium was found to be ethylene glycol (Prestone), which can be used with a jacket outlet temperature of 300 deg. fahr. It has the advantage over water cooling of permitting a 75 per cent reduction in radiator area, due to the greatly increased temperature difference between the cooling medium and the air.

Another outstanding power-plant development of the past year was the development of the venturi type of cowling for radial engines. The use of this cowling removes the greatest objection to the radial air-cooled type of engine—its excessive drag. In the free-for-all high-speed race at the National Air Races in Cleveland last August, radial air-cooled engines with venturi cowling placed one, two, three against the field.

An interesting trend in airplane power plants is the increasing use of geared engines, both direct-air-cooled and indirect-air-cooled (liquid-cooled), for the purpose of reducing propeller speeds to a point where the propeller can operate at its optimum efficiency. With the problems involved in the use of reduction gearing successfully solved, it seems logical to expect that engine speeds will increase to a point comparable with those of automobile engines, thus giving increased thrust horsepower for a given engine displacement and size.

Airplane Design and Construction[2]

In 1929 airplane design and construction made rapid advances, more so, perhaps, than in any of the immediately preceding years. Unlike the year before, a number of really new types were brought out and successfully proved. The decrease in plagiarism of designs and the increase of individual effort were especially noticeable. A number of new methods of construction were developed, and design with a view to mass production was vastly improved. As in the past few years, much attention was paid to improvements in details, both in the aerodynamical properties of airplanes and in their structure. Many new large airplanes were completed as well as many exceptionally small ones. The number of open-cockpit biplanes still predominated, as in the past, but did not increase as it had in the years past but rather decreased. On the other hand, much more attention was paid to the development of flying boats, seaplanes, and amphibians.

In design, the influence of the Aeronautics Branch of the Department of Commerce was shown by the considerable decrease in "fly-by-night radical and revolutionary designs," and as well in general improvement in all planes with respect to thoroughness in engineering and proper attention to details.

In the first half of 1929, 72 new approved-type certificates were awarded by the Department of Commerce as against 59 in the last half of 1928, an increase of 22 per cent. In the third quarter of the year 52 certificates were awarded as compared with 36 in each of the two previous quarters, an increase of 44.5 per cent. It should be remembered that these certificates signify only the approval of new types for production and do not represent the quantity of planes of each design approved.

As to the detail design of airplanes produced in 1929, advance in aerodynamic "cleanness" is immediately apparent.

More than ever the tendency has been toward the monoplane rather than the biplane, and again toward the "clean" cantilever monoplane. Besides the efforts made to reduce resistance through the reduction of frontal area, much attention was paid in the past year to the elimination of induced drag caused by the mutual interference between the various exposed parts of the airplane. The efforts in this direction have resulted especially in cleaner landing gears, with more attention given to the relative location of the individual members. In some landing gears these members are completely eliminated by supporting the wheels by a cantilever beam. The landing gear of the Bellanca Pacemaker is an example of the truss type, much attention being paid to the mutual interference of the individual members. Many production designs now include as standard equipment fairings for wheels and tires, while on the Eaglerock Bullet the resistance of the wheels is almost practically eliminated by retracting the greater portion of them into the wing.

In the design of wings there has been a slight tendency toward increased aspect ratio to give better cruising performance. This has been more apparent in some European designs than in American ones. Little progress was made during the year with regard to the development of better profiles for wing sections. This was chiefly due to the dependence of commercial organizations upon government laboratories for information. However, at present many manufacturers are developing aerodynamical laboratories of their own, which should effectively advance the investigation of their individual problems.

Though the N.A.C.A. type of engine cowl was developed in 1928, it was not until the past year that it was really tried on a commercial scale. With the increased use of this cowl for radial air-cooled types and the development of clean air-cooled in-line engines, designers have paid a great deal more attention to cleanness in fuselage lines, resulting in somewhat rounded fuselages, many of which are oval in section. An excellent example of the result of good streamlining is the low-wing Travel Air monoplane of conventional American construction of welded steel-tube fuselage and wood wings, all fabric-covered. This plane attained a speed of 200 m.p.h. Also worthy of mention is the Eaglerock Bullet, a land plane with cantilever low wing and retractable landing gear.

Aerodynamically, most planes were quite conventional except for the Bellanca Tandem and the Furnic Ente. The Bellanca Tandem opens an entirely new field of development for multi-engined planes. The engine installation is new, while the wings are a further development of the Bellanca Roma or K-type brought out in 1928. The Furnic Ente is a twin-engine design differing from the usual Ente type in that it has two stabilizers, one in front and one behind.

[2] Prepared by Richard M. Mock, Aeronautical Engineer, Bellanca Aircraft Corp. (at the time of writing, on leave and with the Ernst Heinkel Flugzeugwerke, Warnemünde, Germany).

From a structural point of view there has been an increasing use of duralumin, and especially of the corrosion-resisting alloy Alclad. In the United States there has been little or no work done with light-gage sheet steel, especially of the so-called stainless variety. This is used extensively in England and is being tried experimentally by Heinkel in Germany.

One of the most interesting developments in wing construction is the Barling monoplane of Nicholas-Beazley. Practically all American wings employ the two-spar construction, but one of the leading manufacturers uses three spars. In Europe there has been considerable development in single-spar metal construction, especially the English "mono-spar" and the German B.F.W. commercial planes.

More planes have been produced with dural fuselages than heretofore, and the number of dural tail surfaces has also increased quite rapidly.

From a production viewpoint there have been many advances. The development of the Consolidated Fleet Junior is the most oustanding example of a good production design. Also in this class is the new Great Lakes training plane.

Toward the close of the year there was evidence of an increased activity in the development of seaplanes and flying boats. This branch of aeronautical development has been somewhat neglected in the United States, except by Loening, Sikorsky, and Ireland. However, 1929 brought the development of the large Consolidated Commodore, the Hall, the Keystone-Loening Commuter, and the Great Lakes Amphibian, as well as a number of others that are not yet in production. Many European manufacturers have arranged for American production of their products. Savoia-Marchetti flying boats are already being built. Three German manufacturers are planning American production; Heinkel has developed an amphibian of medium size expressly for the American market, while Rohrbach has announced an American company presumably to produce the Roman and Rocco types. Dornier, too, has an American connection for fabrication of the Super Wal and perhaps the 12-engined giant DO-X, which last fall carried 169 people, establishing a world's record. Also planning American production under license are the English Blackburn and the French Schreck companies, both experienced organizations in flying-boat development.

In America the large passenger land transport plane has been receiving much attention. In 1929 the Curtiss plane Condor, the Fokker F-32, and the twin-engined Burnelli were developed, while production was increased on the Ford tri-motor, the Fokker tri-motor, and the Keystone Patrician. At the time of this writing the four-engined Fokker F-32 is the largest passenger land plane, carrying 32 people, and work is being rushed in Germany to complete the 50-passenger Junkers J-38, a design closely resembling the large Junkers G-31.

As regards cabin passenger planes, it is the writer's opinion that the German transports are much more comfortable, though great progress is being made in this direction in America.

All over the world there has been a tendency to increased power in airplanes, and in many cases, instead of being used to provide greater safety or better performance, it has been employed to overcome difficulties in design in what would otherwise be called exceptionally poor airplanes. The increased use of higher-powered engines, especially the Wasp, Hornet, and Cyclone, is noticeable, while in Europe builders have gone to even higher powers, employing 700–800-hp. and even 1000-hp. water-cooled engines on commercial airplanes.

Aerodynamics[3]

The past year has seen practical progress in the art of streamlining. Commercial designs have shown a tendency to imitate racer practice in reducing parasite resistance to a minimum. For example, commercial designers are using retractable landing gears (as in the Alexander Bullet) which have a resistance approximately 50 per cent of that of the fueslage. Monocoupe fuselages of nearly perfect streamline form are being built in both wood and metal. The filleting of wings into fuselages, and of struts into wings, is being considered as worthy of attention from a resistance point of view. Without evidence of systematic wind-tunnel experimentation, attempts are being made to decrease wheel resistance by providing wheels with fairings. The N.A.C.A. or venturi cowling has been successfully employed on a number of designs to reduce the head resistance and increase speed, although designers of single-engined planes are not adopting this type of cowling any too rapidly as it undoubtedly impedes vision. In England the Townsend ring, an annular surface placed round and at some distance from the cylinder heads, is apparently producing real aerodynamic improvement, and the device is of the simplest possible character.

In the design of airfoils, particularly in England and France, it is now more frequently the practice to design airfoils theoretically, and to employ airfoils with a constant center of pressure, partly with a view to increasing the stability of the airplane and partly with a view to decreasing the stresses on the spars. The successful employment of constant-center-of-pressure wings has also led designers to think more seriously of the single-spar cantilever monoplane. With a constant center of pressure achieved, single-spar construction offers decided possibilities. Designers are also giving much more attention to the careful aerodynamic design of cantilever monoplane wings. Besides taper in plan and thickness so as to provide both greater aerodynamic efficiency and greater strength at the root of the wing, it is now customary to give consideration to the center-of-pressure travel. By suitable design, and appropriate choice of sections along the span, it is apparently possible to produce tapered wings of real efficiency, high lift, and constant center of pressure. At the same time, by using constant-center-of-pressure sections at the tip, it is possible to minimize the dangers of flutter.

As regards control surfaces, a number of tendencies may be noted. Floating wing-tip ailerons, always in the line of wind, no matter what the angle of incidence of the main wing may be, have been tried out in a number of wind tunnels. The advantage of such ailerons lies in the fact that, even if the main wing is at or near the stall, the ailerons are always at zero near the wind, and therefore maintain effective rolling moment, while the adverse yawing moment either disappears or becomes negligible. In the Guggenheim Safe Aircraft Competition, the Curtiss Tanager is employing this type of control, whereas the Handley Page entry employs the so-called slotted aileron, in which the Handley Page automatic slot is placed at the leading edge of the wing and helps the lateral control at the stall. The so-called slot-and-flap aileron has been universally adopted on all machines used by the British Government.

The Handley Page Company has successfully developed a so-called "interceptor," in which the action of the ailerons working with a front slot may be still further strengthened. In this device the front slots may remain automatic, but the upgoing aileron raises a "spoiler," a flat plate normally lying flush with the wing. This spoiler still further decreases the lift on the side of the upgoing aileron, and also increases the drag on the side of the upgoing aileron.

The Safe Aircraft Competition has brought to light a series of interesting attempts to improve the airplane at the lower range of the scale. The special devices employed in wing design include: The automatic front slot working in conjunction with rear flaps, with which it is mechanically connected (Handley

[3] Prepared by Alexander Klemin, Daniel Guggenheim School of Aeronautics, New York University. Assoc-Mem. A.S.M.E.

Page); the automatic front slot working in conjunction with a manually operated rear flap (Curtiss); variable camber and area (Burnelli); variable camber and incidence (Wentworth); and conversion of a monoplane into a biplane of very small gap (Cunningham-Hall).

The realm of aerodynamics, broadly speaking, may be considered to comprise the activity which has been shown in the design of variable-pitch propellers. Mechanical control, electrical control, and hydraulic control are now being supplemented by efforts at purely automatic control, with action dependent on the fine correlation of aerodynamic and dynamic forces.

The establishment of the Autogiro on American soil has led to increasing interest in this form of aircraft. One of the main difficulties previously experienced with this machine has been the slowness of starting of rotation of the main blades. By raising the tail surfaces in appropriate fashion so as to break the symmetry of flow, it is now possible to secure blade rotation with much greater rapidity.

The Isacco Helicogyre may perhaps be said to be a development of the Autogiro. It involves freely hinged blades as does the Autogiro, but the lifting blades are driven round not by windmill action alone, but by the placing of auxiliary engines near the tips, which actuate auxiliary propellers. It is hoped in this fashion to augment the admirable qualities of the Autogiro by increasing steepness of climb and rapidity of take-off.

Air Transport and Other Civil Flying[4]

Continuing the development described in the Progress Report for 1928, further extensions of air routes have been made in the United States. Perhaps the most outstanding feature in this connection has been the extension of the U. S. air lines to South America. This began with the extension of the Pan-American Airways route from Havana to Central America and thence through affiliated companies on the West Coast. At the same time a competitive group has obtained mail contracts from certain South American nations, has organized its personnel, and is just about to place into operation a competitive route running down the East Coast of South America to Rio de Janeiro and Buenos Aires. The traffic carried by practically all lines in the United States has undergone considerable increase, and this increase shows no signs of slacking up. While the air mail has had a very consistent growth, the outstanding feature on the traffic side has been the changed attitude of the public toward passenger services and the increased willingness of passengers to fly. As a result of this, passenger traffic, which was formerly lagging behind that of Europe, is now experiencing a very healthy growth and promises to become, within a short time, a most important source of revenue for the operators of air routes. Similar increase has been noted in the miscellaneous flying services and in the operation of flying schools. Because of its bearing upon transport operations, it is noted here that the increase in pilots is keeping up quite closely with the increase in airplanes. Thus it is evident that there will be no shortage of pilots as a whole, although for a time there may be some shortage of the very experienced types of pilots.

Among the elements of economic importance to the operators of air routes might be noted the recent tendency toward consolidation which has resulted in the merging of a considerable number of smaller operators into a lesser number of substantial groups controlling connecting routes. This development is somewhat comparable with the consolidations of the early days of railroading, and the air routes are becoming combined into well-organized systems somewhat similar to those which now exist in railroading.

[4] Prepared by Archibald Black, President and General Manager, Black & Bigelow, Inc., Air Transport Engineers, New York, N. Y. Mem. A.S.M.E.

Incidental to this development, a considerable volume of additional capital has been drawn into the operating side. As this is being written, there is under consideration by the U. S. Post Office Department the possibility of some adjustment of air-mail contracts which may affect those operators holding contracts at the higher rates. The indications are, however, that the attitude of the Post Office Department will be quite reasonable and that no operator will be expected to accept a readjustment of rate which forces him to run at a loss, if this can possibly be avoided.

The movement toward the creation of private flying clubs, which began here within the past two years, is now producing some tangible results and is thus providing facilities which should give great encouragement to the private owner of airplanes and result in further increase in private flying.

Among the technical developments affecting air-transport operation might be noted the increase in size and horsepower of airplanes, of which the 32-passenger Fokker and the 50 passenger Dornier DO-X are recent examples. This is a very natural trend due to increased traffic and to the demand for still higher speed. As the traffic grows still further, similar further increases in size of airplanes may be expected until the equipment in use attains capacities very much greater than at present. The recently developed N.A.C.A. cowling is of most important economic advantage to the airway operator as it increases the speed of his airplanes without affecting the gasoline consumption. This is important from three viewpoints: First, it enables him to speed up his operations; second, it enables him to get more mileage with the same flying cost, or, conversely, a lower flying cost for the same mileage; third, it has a still further advantage in making it possible to get more miles per year with the same equipment. Recently, some experimental flights were made with the Opel rocket-propelled airplane. At present, however, this is purely a scientific toy.

The recent experiments of the Guggenheim Fund in connection with fog flying are being carefully watched by all operators and have been very promising up to date. Because of these experiments, the coming year may find the operator in a much better position to master the question of fog than he has been at any time heretofore. The use of radio in airways in the United States is becoming much more general, and several operators are now depending upon radio communication with airplanes in flight for the purposes of furnishing weather information and keeping in touch with pilots en route.

The railroads are now showing considerable interest in air-transport development, and in a few cases joint air-rail services have already been organized in which the railroad and airplane operations are coordinated and through tickets sold so that the passenger can make a through flight, using the train for part of the way and the air-service company for the remainder of the trip.

Within the past twelve months the Department of Commerce has made certain modifications in its regulations governing the licensing of pilots. These changes constitute a general tightening up of the previous regulations, so that a pilot who is licensed to fly a certain type of aircraft will hereafter be required to take an additional examination to fly a type very much larger than the one on which he obtained his license.

As this report is being written, the manufacturing side of the industry is undergoing a certain amount of readjustment, due to an increase of production at a greater rate than the increase in sales, combined with the seasonal drop in sales which usually occurs in the fall. This addition is most noted in the case of the smaller types of airplanes such as are sold to private owners. While this readjustment period will be a painful one for certain of the manufacturers, particularly those who are not very well

financed, it is a passing phase, and the manufacturing side of the industry and should again be in sound condition when the seasonal increase in sales develops in the spring of 1930.

One of the interesting developments of the past year was the entrance of General Motors Corporation into the aviation field through the purchase of a substantial interest in the Fokker Company, and by close association with the Bendix Aviation Corporation through ownership of about twenty-five per cent of its stock.

Table 2 shows the continued growth of air-mail traffic and mileage development in the United States, while Table 3 shows the air-transport mileage of the world. It will be noted from this latter table that the lead which was attained by the United States between 1925 and 1926 has not only been held but has been very substantially increased in the past year.

TABLE 2 MILEAGE AND TRAFFIC STATISTICS FOR PRIVATELY OPERATED AIR-MAIL ROUTES WITHIN THE U.S.A., FOR YEAR ENDING JUNE 30, 1929[1]

Month (all routes)	Length of routes, miles	Miles of service actually flown	Total weight of mails dispatched, pounds	Amount paid to contractors
July, 1928	12,021	653,883	214,572	$445,238.41
August, 1928	11,977	731,714	419,357	821,005.01
September, 1928	11,977	749,156	423,838	843,691.44
October, 1928	12,169	784,663	465,688	915,998.56
November, 1928	12,504	731,027	425,405	851,390.06
December, 1928	13,791	891,811	541,632	1,094,782.54
January, 1929	14,060	795,293	488,709	955,114.33
February, 1929	14,060	778,329	434,260	865,042.52
March, 1929	14,264	912,760	524,537	1,047,657.78
April, 1929	14,400	885,737	508,672	1,003,718.32
May, 1929	14,334	1,135,953	588,428	1,160,089.23
June, 1929	14,345	1,148,403	598,494	1,161,461.00
Totals	159,902	10,198,729	5,633,592	$11,165,189.20

[1] Compiled from Post Office Department figures by Black & Bigelow, Inc., New York, N. Y.

TABLE 3 AIR-TRANSPORT MILEAGE OF THE WORLD—OPERATIONS OF SCHEDULED SERVICES IN AIRPLANE-MILES

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Australia	....	....	......	......	235,582	262,895	352,847	417,970	453,580	641,831
Austria	....	....	......	......	......	......	......	......	245,043	383,002
Belgium	....	....	......	......	......	160,000	144,500	......	......	......
Canada	....	....	......	......	......	294,778	446,648	631,715	......	......
Colombia	....	2,687	53,650	125,678	134,375	169,500	183,206	......	......	......
Czechoslovakia	....	....	......	......	......	126,400	48,300	170,895	257,888	605,314
Denmark	....	....	......	......	56,000	......	114,500	126,730	116,798	122,215
France	....	505,500	1,460,000	2,015,000	2,115,000	2,249,000	2,946,000	3,243,900	3,755,369	3,753,133
Germany	....	....	......	842,986	885,881	1,860,000	3,070,000	3,816,144	5,921,593	7,030,565
Great Britain	168,000	644,000	225,000	717,000	943,000	936,000	862,000	840,000	769,000	......
Italy	....	....	......	......	......	......	......	......	824,474	1,236,913
Mexico	....	....	......	......	......	......	......	96,800	146,400	......
Netherlands	....	50,850	217,000	246,200	336,000	482,800	679,753	597,500	813,510	1,007,920
Poland	....	....	......	66,293	142,057	233,923	465,847	......	654,873	630,175
Soviet Russia	....	....	......	......	......	288,600	292,595	311,000	......	......
Sweden	....	....	......	......	......	69,280	248,610	222,000	206,766	208,729
Switzerland	....	....	......	......	......	268,400	87,427	210,340	459,720	330,496
United States	393,066	880,028	1,828,354	2,329,296	1,743,030	2,220,761	2,910,611	4,407,263	6,009,226	9,888,307

PROGRESS OF NAVAL AVIATION[5]

Naval-aviation progress during the past year has continued to demonstrate the wisdom and soundness of the Navy's Five-Year Building Program as authorized by act of Congress approved June 24, 1926. Progress toward the accomplishment of this program is continuing satisfactorily, and it is important that this program be completed as authorized, on time and without material changes.

During the year, naval aviators flew a total of 205,421 hours. The average pilot flew about 216 hours, or about 19 per cent more than in the previous year. In the Fleet approximately 285 planes were being operated. Scouting, torpedo and bombing, observation, and fighting planes were carried on the *Lexington*, *Saratoga*, and *Langley;* and fighting and observation planes were operating from catapults on the battleships, while each light cruiser operated two observation planes.

The year opened with the Fleet's annual cruise in southern waters, participated in, this year, for the first time, by the two carriers, *Saratoga* and *Lexington*. Together with the battleship and cruiser planes, the carrier planes demonstrated every possible form of offense against surface craft and shore bases. Torpedo planes delivered attacks through smoke screens, fighting planes delivered attacks on surface vessels and shore stations, while radio-equipped observation planes kept the ships constantly informed of all phases of the "War." A night air raid sent out by one of the carriers while she was yet 150 miles off the coast of Panama, theoretically destroyed the locks. Two hundred forty-seven planes took part in the maneuvers and flew 4397 hours over nearly half a million miles, in every kind of weather and under varying conditions, without a single serious accident. The authorization of an additional aircraft carrier evidences Congress' realization not only of the need for, but of the expediency of, this type of tonnage in the Fleet. However, there is still an urgent need of additional carrier tonnage to provide for the expansion of the air arm in accordance with its proportionate relationship to the Fleet as a whole, and in order to provide the parity of aircraft-carrier tonnage allowed in the Washington Limitation of Armaments Treaty.

The Navy now has on hand or in production aircraft suitable for carrying out any mission which the forces afloat may be called on to accomplish. There are two new types of fighters being produced and a third type being experimented with; deliveries are being made on a large order for a modification of the present type of observation plane, while two new experimental types are under test; a modification of the standard torpedo and bombing plane is in production, and several experimental types are being tested; development of the patrol-type program, along both monoplane and biplane lines, is proceeding satisfactorily; of these, 55 airplanes have been contracted for on the basis of the development of the biplane PN-12, and a small production order placed for monoplane patrol boats similar to the XPY-1.

To provide all types of planes with suitable power plants, aircraft-engine development has been stressed particularly on the score of increased reliability along with further reduction in weight—factors which are mandatory in the design and construction of naval aircraft because of the limitation imposed by shipboard operating conditions. The air-cooled engine ranging in power from 200 to 600 hp. is standard in all types of Navy planes.

The two detachments of the naval air service which provided perhaps the most spectacular demonstration of successful aircraft operation during the year were the Marine Detachment in Nicaragua and the Naval Aerial Survey Detachment in Alaska. In Nicaragua, six tri-motored transport planes have been in daily use transporting personnel, food, ammunition, and other supplies through every sort of weather over rough, wild country. Ground units have been communicated with at least once daily from the air, and aerial escorts have been provided marching units. In Alaska, four amphibian planes continued the work of mapping which was so successfully initiated in 1926. The survey has proved to be of great value in the investigation of the mineral re-

[5] Prepared by Rear-Admiral Wm. A. Moffett, U. S. N., Chief of the Bureau of Aeronautics, Washington, D. C.

sources of Alaska, the location of forests, the discovery of new sources of water power, and in road and trail building through hitherto unpenetrated territory. The most outstanding single accomplishment of the expedition was the discovery of a 900-acre lake within three miles of the coast and at an elevation of over 2500 ft. The fall from the lake level to sea level is so abrupt that dam construction is unnecessary.

Progress on the Navy's lighter-than-air program is marked by the beginning of actual construction work on the first of the two dirigibles contracted for in 1928, and by the completion of the *ZMC-2* (metalclad) airship. Operations with the *Los Angeles* have included training flights and those on which tests of various apparatus have been made, principally the device for attaching airplanes to the airship, and mooring devices. A number of plane hook-ons have been successfully carried out.

Developments of the past year have conclusively shown the immense value of aircraft carriers, and it is considered that the most important requirement of naval aviation at the present time is to secure as soon as possible the additional carriers necessary to give the Navy the authorized carrier parity of tonnage allowed under the Washington Limitation of Armaments Treaty.

Military Aircraft Progress in 1929[6]

A more complete and general acceptance of aircraft as a most vital factor to any scheme of national defense coupled with steady increase in their performance and effectiveness, has marked the progress of military aeronautics during the past year. Keeping pace with the development of new and better equipment, those in charge of its employment have enlarged the field of aerial activities until hardly a tactical problem is now considered without giving much serious attention to the action of friendly and enemy air forces. Military aircraft should not be expected to displace

Fig. 1 New Type of Pursuit Plane Manufactured by the Boeing Company and Powered With a Pratt & Whitney 420-Hp. "Wasp" Engine

(This type is known as the P-12 and is in use at the present time in certain service squadrons.)

any essential element in our present organization, such as the artillery, infantry, or the corps of engineers. A most important function is to cooperate with these various arms, increasing the efficiency of each as well as bringing a tremendous offensive machine into play against the enemy.

There are six general types of heavier-than-air craft in general use by the United States Army today. They consist of training airplanes, observation, attack, pursuit, light bombardment, and cargo or transport airplanes. While there are many sound arguments against any considerable number of different types of airplanes in the service, yet it appears absolutely necessary to build many types in order to obtain airplanes of greatest effectiveness for the particular work which is required.

During the year the training planes in use were of the same general type as used the previous year. In place of the 180-hp. water-cooled Wright Hispano-type engine, we find a 9-cylinder air-cooled radial engine of the type which Colonel Lindbergh used in his famous transatlantic flight. The change represents an increase of approximately 45 hp., without an increase of overall weight, and was made due to the availability of the new engine and the desire to use the air-cooled type. A complete overhaul is given these engines after approximately 200 hours' training service. The air-cooled engines are now fitted with elaborate air filters attached to the carburetor air intake or air-intake pipes which conduct the air from the top and inside of the fuselage, schemes which eliminate a considerable portion of the usual cylinder wear due to operation upon dusty fields. It is predicted by many that much lighter and lower-powered airplanes will be used in the future, but the average Army pilot apparently favors a liberal amount of power, giving the airplane a maximum speed

Fig. 2 Experimental Thomas-Morse Pursuit Airplane Known as the "Viper"

(This plane is interesting from two angles: construction—corrugated aluminum alloy; powered with a 650-hp. Curtiss "Chieftain" engine.)

which is at least 40 m.p.h. above minimum. All Government training airplanes are now of the steel-tube-fuselage type, with a biplane structure of fabric-covered wooden wings. The steel-tubing structure has proved more satisfactory in every way, and appears to offer a surprising amount of protection to the crew in event of a crash. Training airplanes of this type have crashed into the ground from tail spins repeatedly without fatally injuring the occupants. The ability to stand abuse has been given a great deal of attention by engineers, a quality which has inspired the development of more rugged landing gears and wheels. The "Musselman" or "doughnut" type of wheel whose tire is very large in section and is mounted directly upon the hub, uses an air pressure of only 4 to 8 lb. per sq. in. This equipment give promise of cushioning the severe landings experienced while training students.

In the observation type of airplane the tendency to adopt the air-cooled engine is also present, although not so universally recognized yet as in the case of the training airplane. For several years the majority of the observation airplanes have been equipped with 410-hp. water-cooled Liberty engines. The wide use of the Liberty engine in recent years has been due to a surplus of such engines since the war period. Each year has added its improvements to the Liberty engine, until today many pilots still consider it a most dependable aircraft engine. The Government has definitely dropped the Liberty engine as equipment for any new-type airplanes. The use of radial air-cooled engines effects a saving of from 300 to 400 lb. installed weight in an observation

[6] Prepared by S. P. Mills, Matériel Division, Air Corps, U. S. A., Washington, D. C.

airplane, a fact which greatly increases the rate of climb, and improves the take-off and all-around performance at higher altitudes. The maximum speed at the ground is apparently no greater, but increased performance along other lines appears to justify such installations.

There are three observation airplanes in use today: the Douglas series known as the O-2 (the O-2H being used in considerable numbers), the Curtiss series, and that manufactured by the Thomas-Morse Corporation. The Douglas O-2H airplane which is standard in the Air Corps this year is equipped with a water-cooled Liberty engine mounting a nose radiator and providing an exceptionally roomy cockpit for the gunner immediately to the rear of the pilot. It is of interest to note here that the Mexican Government has purchased nine new airplanes of the general O-2H type but equipped with Pratt & Whitney 525-hp. Hornet engines. The Mexicans report excellent performance from these airplanes, particularly under conditions where they are operated from the many very high-altitude landing fields throughout Mexico. The Curtiss series of observation airplanes mount either the water-cooled Liberty or the water-cooled Curtiss D-12 engine. Future plans for this series will use both air-cooled radial engines and liquid-cooled engines of higher horsepower. The Thomas-Morse observation airplanes will use radial air-cooled engines.

Three different types of fuselage construction are represented by three different makes of airplanes: the Douglas using a structure made of chrome-molybdenum steel tubing welded at the joints, the Curtiss, aluminum-alloy tubing riveted or bolted, and the Thomas-Morse, using a corrugated aluminum-alloy shell. Time alone will tell which type of construction will find the greatest favor in the service. Each type apparently offers the crew of a plane a much greater protection in the event of a crash than the wood-wire construction. As judged from the experiences of the Air Corps during 1929, the tendency in observation practice appears to increase the performance by the addition of more horsepower and the material reduction of weight of the power plants. Another marked tendency is the increasing use of metal. It is not unlikely that in the future we shall see all-metal observation airplanes whose performance is very little behind that of the combat and pursuit class, some of which may use two or more engines and possibly carry a crew of more than two men.

In attack aviation the types generally used have been a sort of converted observation airplane powered by either an air- or water-cooled engine. The year has witnessed an increase in speed of attack airplanes and a great deal of additional experience on the part of attack personnel. Indications point toward the development of a specialized attack airplane whose forward speed at ground level will be considered the most important single feature, with maneuverability, vision, and machine-gun operation important additional considerations. It is possible that certain classes of attack airplanes may be provided with limited quantities of bullet-glancing armor plate placed around certain vital points of the cockpits and engines. Future attack airplanes may be equipped for doing much of their work under cover of darkness. The attack upon troops, and particularly upon supply trains, bridges, roads, and other small objects immediately in the rear of the scene of action will undoubtedly play a most important part in military campaigns.

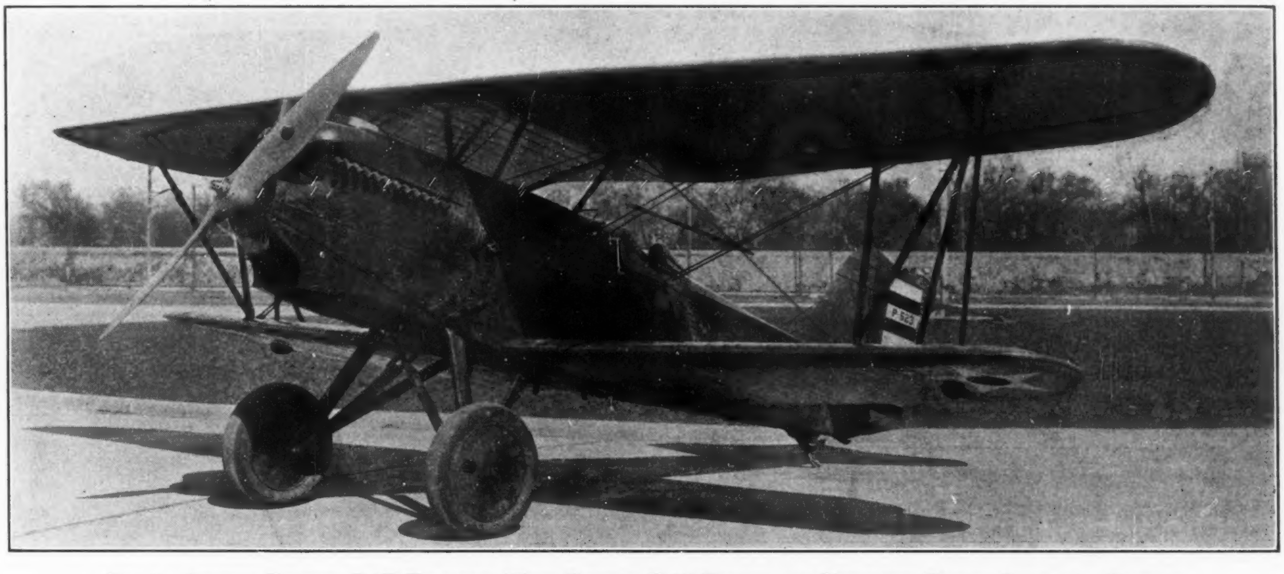

FIG. 3 CURTISS PURSUIT P-1B EQUIPPED WITH CURTISS D-12 ENGINE AND ETHYLENE GLYCOL SYSTEM OF COOLING
(Note the very small radiator necessary to give the required cooling.)

The Curtiss and Boeing companies have provided the majority of service pursuit airplanes in present use. The past year has witnessed the equipping of certain squadrons with new pursuit airplanes powered with the radial air-cooled engines. As in the observation, the radial engines increase the all-around performance of pursuit airplanes. The speed due to the change of engines alone has not materially increased, but the airplanes themselves represent an advancement in this line. The new radial-engine-powered pursuit airplanes do not appear to have quite the diving properties of the water-cooled, but their rate of climb and performance at altitude are unquestionably better. A most interesting development during the year has been the substitution of ethylene glycol for water as a cooling medium in the radiators of pursuit airplanes. As a result of this scheme, the weight of a pursuit airplane is reduced about 100 lb., the size of the radiator is decreased 70 per cent, and the fuel economy for a given horsepower is considerably improved. Due to the high boiling point of this liquid (387 deg. fahr.), it is possible to operate the engines at an outlet temperature of 300 deg. with a loss of only two per cent in horsepower. Service tests of over 120 hours' satisfactory operation with this cooling system, indicate that the length of life of engines will not be materially decreased. Researches are now being conducted which will determine this more accurately. Should the new cooling system meet favor throughout the service,

it is likely that it will be much used in the future by racing airplanes and certain classes of military aircraft.

Paralleling the development of ethylene glycol cooling has been the design and development of a series of cowls capable of entirely enclosing radial air-cooled engines. Speed increases of up to 17 m.p.h. have been recorded on pursuit planes using such equipment. In certain cases the cooling of an engine at full throttle has been somewhat impaired and the visibility of the pilot considerably reduced. While using a Matériel Division cowl on a P-12 pursuit airplane equipped with a supercharged Pratt & Whitney radial air-cooled engine, Captain R. G. Breene of Wright Field averaged 186 m.p.h. over a triangular course in the free-for-all race at Cleveland on September 2, 1929. The work of this development has been carried on by the Matériel Division of the Air Corps and also by the National Advisory Committee for Aeronautics. Although such cowls possess certain disadvantages, nevertheless any equipment which increases the speed of an airplane by 10 per cent must be reckoned with in future developments.

An effort to increase the speed of pursuit airplanes which is being followed closely is the use of a Curtiss Chieftain, a 12-cylinder double-bank radial air-cooled engine. Such an engine, while delivering in excess of 600 hp., has the same overall diameter as the Wright J-5 Whirlwind engine which delivers 230 hp. The Chieftain engine is still being experimented with in the laboratories of the Curtiss Company and the Matériel Division, and every effort is being made to develop this engine for pursuit and observation work. Possessing as it does its high horsepower and light installed weight characteristics of air-cooled engines, it has the further advantage of streamlining satisfactorily into a fuselage and obstructing the vision of the pilot to a less extent than the single-bank radial of equal horsepower.

American pursuit airplanes are generally of the biplane type and constructed usually of welded steel tubing or of square duralumin tubing riveted and bolted together. As a result of observing the winners of the races of recent years, it would seem that the low-wing, all-metal monoplane will some time find its place as a combat and pursuit machine. It is likely that the retractable landing gear and increased horsepower with greatly reduced radiators will be the tendency in future pursuit development.

The development in bombardment aviation has been of a sound, consistent nature, resulting in a steady though not revolutionary increase in performance. The Liberty engines have gradually been displaced by Pratt & Whitney Hornet and Wright Cyclone engines of 525 hp. each, with a resulting conservative increase in speed and a considerable improvement in rate-of-climb and performance characteristics. The Keystone bombers thus equipped have shown speeds of over 120 m.p.h. coupled with satisfactory ability to handle big loads. The year has witnessed the supplying to the service of several Curtiss Condor bombing airplanes each equipped with two 625-hp. geared Curtiss Conqueror engines. The use of geared engines appears to give a material increase in propeller efficiency, and it is probable that the geared engine will be used to a greater and greater extent in future machines of this kind. The United States is probably a little behind certain other nations in the employment of geared power plants. The year 1929 has witnessed the real beginning of the use of gearing in Air Corps bombing and observation airplanes. The twin-engine type of bomber appears to be still held in highest favor by the service as it gives a better distribution of defensive armament. The development of the Fokker F-32, a large transport monoplane powered with four 525-hp. engines, is being watched with much interest by various countries. This plane, with a reported maximum speed of 155 m.p.h., is likely to furnish some valuable ideas to the designers of bombardment airplanes. The construction of the modern bombing airplane follows much the same type as other classes: namely, the welded-steel-tube fuselage as used by Keystone Company and the bolted and riveted duralumin fuselage as used by Curtiss Company. Again the tendency is toward a greater and greater percentage of metal construction and the addition of more horsepower.

Cargo and transport airplanes for the transportation of ammunition, supplies of all kinds, and even of troops, will undoubtedly be in great demand during the next emergency. In general it is expected their designs will follow that of a modified bomber with ability to carry tremendous loads from restricted fields, which means the probable employment of geared engines and controllable-pitch propellers. In all probability the speeds of bombers will be very much increased, using speed as a defensive measure rather than carrying so much weight in the defensive armament.

Fig. 4 New Douglas Advanced Training Airplane
(Similar to the Douglas observation plane except that it is powered with a Pratt & Whitney "Wasp" engine instead of a Liberty engine.)

The year 1929 will be remembered in history of military aeronautics as the year during which the wartime Liberty engine was finally discarded, being replaced largely by the new radial air-cooled engines. It will also be remembered for the attempted "come back" on the part of water-cooled engines through the employment of new cooling systems and the installation of several models of geared engines. Other developments too numerous to mention, such as the successful use of propellers which can be adjusted during flight, new high-altitude equipment, photographic equipment, parachutes with a more satisfactory operation, have all been pushed with much interest and painstaking care. Increasing use of metal construction and increased power have each contributed to increasing the performance of our military aircraft. It is imperative that this work of development be continued and that we learn all lessons possible from races, experiences of other countries, and commercial activities, in order that this important branch of the national defense shall be maintained at its highest point of efficiency.

FIG. 5 THOMAS-MORSE O-19 OBSERVATION AIRPLANE POWERED WITH A PRATT & WHITNEY "WASP" ENGINE
(Note the corrugated aluminum-alloy fuselage.)

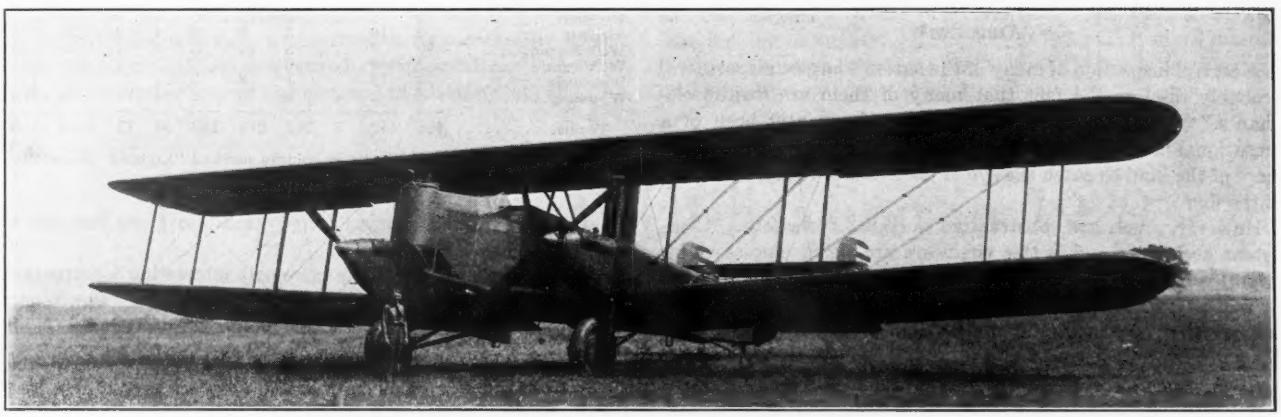

FIG. 6 CURTISS "CONDOR" BOMBER, POWERED WITH TWO 620-HP. CURTISS GEARED "CONQUEROR" ENGINES
(Note that a gunner is placed in the nacelle behind each engine.)

AIRSHIPS[7]

The circumnavigation of the world by the airship *Graf Zeppelin* in twenty-one days total time, or twelve days of actual flying time, was the outstanding aeronautical event of the year. In addition to the around-the-world flight, the *Graf Zeppelin* twice crossed the Atlantic between Lakehurst and Friedrichshafen. Notable flights were also made by this airship over Europe and Asia Minor. In May, the *Graf Zeppelin* made an unsuccessful attempt to cross the Atlantic, but because of engine failure was obliged to put into the French airport Cuers, near Toulon. This event caused some shaking of heads among the airship doubters, but an actual study of the course of events on this occasion showed the extraordinary ability of the airship to make port safely in spite of a must unusual accident. Four out of the five engines suffered broken crankshafts due to torsional vibrations induced by stiffening the couplings between the engines and propellers. With only one engine remaining in operation the *Graf Zeppelin* was able to make port in spite of strong adverse winds. The Zeppelin and Maybach companies, builders of the hull and engines, respectively, of the *Graf Zeppelin*, profited by this accident to study the subject of torsional vibration. The faulty couplings in the *Graf Zeppelin* were replaced by others which eliminated the disastrous periodicity in the power plant.

The two large British airships, *R-100* and *R-101*, of over 5,000,000 cu. ft. gas volume, have been completed and inflated with hydrogen. At the present writing they are practically ready for their trial flights. These airships are of a novel type, differing considerably from the Zeppelin pattern to which practically all previous rigid airships have closely conformed. The usual development troubles in a new type may be expected, but there is no reason for the prognostications of failure of these airships which have been broadcast by their opponents.

The small experimental metalclad airship *ZMC-2*, designed

[7] Prepared by C. P. Burgess, Bureau of Aeronautics, Navy Department, Washington, D. C.

and constructed for the Navy Department by the Aircraft Development Corporation, of Detroit, Michigan, has successfully passed through its trials and been accepted by the Navy. Considering the extreme novelty of this airship, its trials were extraordinarily successful and free from troubles. On the other hand, it should be remembered that this ship has not yet been subject to the crucial tests of flying in rough weather, to continued exposure to the atmosphere, or to severe alternating stresses. A true estimate of the value of the metalclad construction for airships cannot be made until after the test of continued service.

The U. S. S. *Los Angeles* has been throughout the year in almost constant service, although no particularly long or spectacular flights have been made. Important work in the development of handling airships has been carried on with the *Los Angeles*. These developments include extended use of the stub mooring mast, and successful trials with a mobile mooring mast which can be towed in and out of the hangar with the bow of the airship attached to it.

A trapeze for carrying, releasing, and hooking on airplanes has been installed and successfully tested on the *Los Angeles*. Similar experiments have been carried out before with very light airplanes, but the installation on the *Los Angeles* is the first of its kind suitable for continued use, and adaptable to planes of real military value.

The Goodyear-Zeppelin Corporation at Akron has made good progress in the detailed design of the new 6,500,000-cu. ft. airships *ZRS-4* and *ZRS-5* for the U. S. Navy. Many of the girders for the first airship have been constructed, and assembly is now under way in the corporation's new huge airship factory and dock. A great deal of experiment and development work in connection with the details of these airships has been carried on during the year.

AIRPORTS[8]

A careful inspection of many of the nation's largest airports will probably disclose the fact that many of them are "white elephants." The financing of airports has frequently been of a sensational nature, and all too frequently the planning has been more of the kind to catch the eye of the investor rather than that of the flier.

However, much real constructive work has been done. Competent architects and better engineers are being employed for airport work. Plans are generally made with an eye to the future as well as to the immediate present. Airports have been laid out in many parts of the country. A list of airports and landing fields in the United States on June 30, 1929,[9] is given in Table 4.

TABLE 4 AIRPORTS AND LANDING FIELDS IN THE UNITED STATES ON JUNE 30, 1929

	Municipal	Commercial	Private	Auxiliary	D. C. lighted inter.	Lighted	Army and Air Corps	Navy	Total	Sq. miles per airport
Alabama	2	4	..	...	4	...	2	..	12	4330
Arizona	23	4	..	9	...	2	1	..	37	3090
Arkansas	3	5	..	6	...	2	1	..	15	3550
California	53	42	..	23	16	19	6	3	143	1110
Colorado	9	6	..	3	6	5	1	..	25	4160
Connecticut	4	1	..	4	1	2	..	..	10	497
Delaware	...	1	1	4	...	1	..	..	6	325
Dist. of Columbia	...	3	..	...	...	3	1	1	5	14
Florida	15	12	..	8	...	2	1	3	39	1505
Georgia	11	2	..	1	5	2	2	..	21	2810
Idaho	3	...	..	2	2	1	..	..	7	11984
Illinois	8	35	..	8	14	11	2	1	68	835
Indiana	8	15	..	3	10	2	1	..	37	981
Iowa	9	15	..	1	15	6	1	..	41	1370
Kansas	15	9	..	1	6	6	2	..	33	2490
Kentucky	3	4	..	...	2	1	..	..	9	4511
Louisiana	6	5	..	2	...	3	1	..	14	3240
Maine	2	2	..	1	...	1	..	..	5	6000
Maryland	1	4	..	7	...	2	3	..	15	663
Massachusetts	3	12	1	3	2	2	1	..	22	375
Michigan	19	9	..	7	1	5	2	..	38	1525
Minnesota	5	7	..	4	3	2	..	..	19	4460
Mississippi	1	4	..	2	...	...	..	..	7	6695
Missouri	9	6	..	2	2	6	..	..	19	3620
Montana	7	5	..	6	1	1	..	..	19	7700
Nebraska	5	6	..	3	13	3	1	..	28	2750
Nevada	9	1	..	5	3	2	..	..	18	6310
New Hampshire	5	...	..	1	...	...	..	..	6	1557
New Jersey	7	15	..	4	2	5	2	1	31	265
New Mexico	10	2	..	8	1	...	1	..	22	5570
New York	13	21	..	9	1	8	4	..	48	1025
N. Carolina	9	7	..	2	6	2	1	..	25	2100
N. Dakota	5	2	..	1	...	...	..	..	8	8855
Ohio	13	27	..	10	20	12	3	..	73	562
Oklahoma	10	14	..	16	8	2	1	..	49	1430
Oregon	11	4	..	6	3	2	..	..	24	4025
Pennsylvania	15	33	..	15	24	6	1	1	89	507
Rhode Island	...	4	..	4	...	...	..	..	8	156
S. Carolina	3	4	..	3	4	1	1	..	15	2060
S. Dakota	6	7	..	3	...	...	..	..	16	4850
Tennessee	5	3	..	3	...	1	..	..	11	3820
Texas	30	14	1	34	2	8	15	..	96	2660
Utah	3	...	..	4	2	1	..	..	9	9440
Vermont	2	2	..	5	...	...	..	..	9	1075
Virginia	3	10	..	3	8	3	4	2	30	6337
Washington	10	7	..	8	...	3	2	1	28	2460
W. Virginia	2	3	..	5	...	...	..	..	10	2413
Wisconsin	13	19	..	1	8	5	..	..	41	1366
Wyoming	6	2	..	2	16	2	..	..	26	3760
Totals	414	419	3	262	211	153	64	13	1386	2180

NOTE: The number of airports in column marked "Lighted" is included in the other columns and is not additional.

It should be clearly understood that few of these airports and flying fields are beyond the preliminary stages of construction. Airports are like cities: they cannot be built in a day, a year, or even two or three years. It is probably true to say that airports, like many other progressive works of construction, are forever being built but are never completed.

Various trends noted in airport construction during the past year are indicated below.

Proximity and Accessibility of Airports to City. A strong present-day tendency is the location of airports closer and closer to the heart of the city. Close-in airport locations have probably been overemphasized, and the economic pressure of overhead costs will probably soon force airports out in the open country again.

The means of communication, the convenience of communication, and the time of travel from the business sections of cities to their airports are now given full consideration in the selection of an airport, and a general improvement in these features is readily noticed.

Building Construction. One extremely interesting construction this year has been the erection of the "hex-hangar" as a repair shop for the Western Air Express Company at Los Angeles. This innovation will undoubtedly be closely watched, and if the results prove successful, the widespread use of such a hangar as a repair depot is almost sure to follow.

Hangar doors have received special study. Practically all those used today are of the sliding, all-steel-construction type. Some hangar doors are of tubular construction, but the majority are of angle construction. The construction of hangar doors is also divided between the straight-rolling type and the round-the-corner type. The former is apparently in the majority. A recent hangar construction included the installation of motor-operated cantilever doors. The installation of this type of door is still too new for an opinion to be given regarding its general adoption by the aircraft industry.

Many airports now have comfortable waiting rooms and restaurants for passengers comparable to the best found in railroad stations. In addition, clubhouses, swimming pools, and other outdoor sports features are being installed at a few airports for club members.

Weather, Radio, and Communication Service. Reliable weather data are a feature of all the major airports. This has been made possible through the cooperation of the Department of Commerce.

[8] Prepared by John Bonforte, Transcontinental Air Transport, Inc., Washington, D. C. Jun. A.S.M.E.

[9] Reprinted from *Aviation*, Oct. 5, 1929.

The use of radio and of the automatic telephone-typewriter system have also aided greatly in expediting the dissemination of weather data, as well as other pertinent information.

The telephone-typewriter has been found especially useful in the relaying of telegraph messages between the airport and the central telegraph office in the business section of the city.

Service Facilities. Improved service and repair facilities are noticeable at all airports. One of the major improvements is the underground electric fueling pits. The pumps used in conjunction with these electric fueling devices generally have a fueling capacity of 20 to 30 gal. per min.

Field service has also been greatly aided by the improved hangars and repair shops that have been built, where oil and water may be heated on cold days and general repairs on planes and engines conveniently made.

Drainage and Runways. These two parts of airport construction go together, for neither should be planned without fully considering the other.

The importance of adequate drainage at airports can hardly be overestimated, for it is truly the foundation of a good airport. Natural drainage is depended upon at some airports, but it is seldom adequate for all weather conditions. The increased use of hard-surfaced runways is making at least partial artificial drainage imperative. The tendency is, however, to tile the entire airport with pipe of such size that it will continue to function even after many years of silt filtration have partially clogged the pipes.

The trend in runway building is difficult to set down precisely. It varies with the climate, the materials available, the money available, and the uses of the airport. Concrete will probably never come into general use as a runway surface so long as its cost remains where it is at present, namely, between \$2.50 and \$3.00 per sq. yd. of 8-in. thickness.

The trend seems to be to surface the runway as cheaply as possible with oil, asphalt, or other bituminous material, and then to improve it from year to year as finances and requirements dictate.

Cinders, broken stone, and other loose materials have also been used as runway surfaces. While all these have many advantages, such as low cost, excellent drainage surface, etc., they also have such fundamental disadvantages as being very dusty in dry weather, and flying up and knicking the propellers of airplanes taxying across the field. These objections will undoubtedly limit the use of these loosely bound materials to the inferior airports.

Airport Lighting. Airport lighting has probably advanced least in point of efficiency of all the airport construction problems. The reasons for this slow advancement are:

1 Airport managers have only a meager knowledge of airport lighting
2 Few of the lighting companies understand the airport lighting problem. Consequently, they simply modify existing lighting equipment intended for railroad, marine, or airway use and market it for airport use.

In the future, adequate means of lighting runways distinctly will have to be developed. One or two firms are already marketing lighting products for such a purpose. Their efficacy and value are still undetermined.

Marking of Airports. The Department of Commerce is leading the way in the better marking of airports by installing and painting metal cones around each boundary light at intermediate fields, and placing a 6-ft.-diameter ground marker of white crushed stone at the base of each boundary light.

Another necessary marking at airports is the increased use of wind cones. In these days of mile-square airports, a single dirty wind cone flapping indistinguishably a mile away from the point of landing is of little value.

Landscaping of Airports. Airport landscaping is at present only the sketchy dreaming of architects. One finds it in drawings but not in actuality. However, as planning must precede achievement, it is certain that better- and better-looking airports will be built.

Progress in Fuel Utilization in 1929

Contributed by the Fuels Division

Executive Committee: Victor J. Azbe, *Chairman,* A. D. Blake, *Secretary,* John Van Brunt, C. P. Tolman, S. B. Ely, and W. J. Wohlenberg

Although during the past year there have been no revolutionary developments in the field of fuel utilization, there has been a slow but consistent progression in the direction of greater efficiency and lower operating, maintenance, and capital charges. Of particular importance is the gradual adoption of the more advanced methods by those industries which have until recently shown only a slight amount of interest in fuel economy.

However gratifying may be the progress which has been made, there is still ample room for improvement, particularly in the more general application of existing knowledge and methods. It has been demonstrated, for example, that steam may be produced consistently at efficiencies of 90 per cent and above, but the average efficiency of all steam-generating stations is far below this figure. It is believed that the greatest strides in the future will be made not so much in the improvement of the present best methods, but in the adoption of these methods by a larger portion of the fuel-using industries.

It is obviously impossible in a report of this length to refer to all the detailed improvements which have been made. It is the intention merely to summarize the more important advances which have occurred during the past year.

Solid Fuels

Production of bituminous coal during the year 1928 and the first nine months of 1929 was only slightly below the average for the five-year period 1924–1928. It is highly probable that the output for the year 1929 will be above that for 1928, owing to the general increase in industrial consumption and notwithstanding economies in use. In spite of the increased output, the amount of coal held in storage has shown a practically uniform decrease. On July 1 the commercial stocks of bituminous coal in the hands of commercial consumers amounted to about 33,100,000 net tons, the lowest amount reported since 1922.

Table 1 gives the annual production, 1918 to 1928, inclusive, and for the first 224 days, 1922 to 1929, inclusive.

TABLE 1 PRODUCTION OF BITUMINOUS COAL, 1918-1929

ANNUAL PRODUCTION 1918 TO 1928

Year	Net tons	Average no. days worked	Average tons per man Per day	Average tons per man Per year
1918	579,386,000	249	3.78	942
1919	465,860,000	195	3.84	749
1920	568,667,000	220	4.00	881
1921	415,922,000	149	4.20	627
1922	422,268,000	142	4.28	609
1923	564,565,000	179	4.47	801
1924	483,686,538	171	4.56	781
1925	520,052,741	195	4.52	884
1926	573,366,985	215	4.50	966
1927	517,763,352	191	4.55	872
1928	500,744,790	203	4.73	...

FIRST 224 DAYS OF EACH YEAR

Year	Net tons
1925	351,405,000
1926	388,336,000
1927	379,015,000
1928	340,118,000
1929	368,797,000

Owing largely to low price levels (averaging the lowest in thirteen years) the past year has witnessed increased and effective efforts to reduce production costs and bring about a greater percentage of recovery. These efforts have been largely centered in the more extended use of mechanical loaders and conveyers of various types, the adoption of improved mining methods and systems, and more careful supervision. Improvements have been made in ventilation and timbering, and there has been a continued increase in the attention given to safety measures.

Particular care has been given to the cleaning and sizing of bituminous coal. Many new installations of mechanical cleaning equipment have been completed during the year, and more have been contracted for. There has been a progressive and important movement toward standardization of the "prepared sizes," with a reduction in their number. Standard sizes have been adopted during the year by two important producing and marketing organizations.

Production of anthracite during the year 1928 showed a slight decrease as compared with that in 1927, and the 1929 production has about kept pace with the 1928 output. In 1929 the output up to September 21 amounted to 52,193,000 net tons as compared with 52,388,000 tons in the corresponding period of 1928.

The anthracite operators and producing companies are continuing to give more concentrated and effective attention to improvements in mining methods and equipment. Preparation, cleaning, and sizing are being given greater attention than ever before, and have resulted in a marked improvement in the quality of coal as shipped.

Owing principally to conditions in the iron and steel trade, the past year has been one of unprecedented activity in the coke-making industry. The total coke produced during the period Jan. 1-Aug. 1, 1929, with that produced in the corresponding period of 1928, is as follows:

	1928	1929
By-product coke, net tons....	31,577,542	35,950,237
Beehive coke, net tons.......	2,829,500	4,282,300
Total, net tons............	34,407,042	40,232,537

On January 1, 1929, there were 12,544 by-product and 41,288 beehive ovens in existence; 8300 of the latter type were dismantled during the year. The 86 by-products plants in operation in August were producing about 93 per cent of their capacity.

LIQUID FUELS

In spite of efforts to curtail production of petroleum, the first seven months of 1929 showed an increase in production of 12.8 per cent as compared with the corresponding period for 1928. For example, the total domestic production for July-August, 1929, was 576,581,331 bbl. as compared with 511,323,929 bbl. for the same months in 1928.

For several years past and continuing during 1929, improvements have been made in petroleum production methods resulting in appreciably greater recoveries. Repressuring, gas lifts, extraction of gasoline from casinghead gas, and gastight storage tanks are being more generally adopted. Particular attention has been paid to the problem of crooked holes. Improved methods of fractionating casinghead gasoline have placed on the market liquid propane and butane, which products are being adopted for the enrichment of water gas and also as fuel in industrial furnaces.

Refining methods have been improved to give better products, greater yields, and lower costs. The old type of inefficient batch shell stills are rapidly being replaced with continuous tube stills equipped with heat exchangers, air preheaters, and furnaces designed for high efficiencies and for high rates of radiant-heat transfer. Continuously operating units producing only distillates and coke have come in largely as a result of the fuel-oil market. The use of stills operating at high vacua for handling lubricating stocks has been quite widely extended. Refinery boiler plants have been the subject of increased attention which has resulted in marked economies. The rotary clay burners used for many years are being replaced with shelf-type burners which use less fuel and give a better product. The volatility and anti-knock value of gasolines have generally increased. The end point of motor fuels marketed has shown a constant tendency to be lowered. This period has also been characterized by the development of several commercial processes for producing motor fuels of high anti-knock value and a more widespread use of such fuels by motorists. There seems also to have resulted an increased yield of gasoline as a percentage of the crude.

Perhaps the most interesting development in petroleum refining during the past year is the construction of a 5000-bbl-per-day hydrogenation plant which is now under way and the projected building of two others of equal size. The hydrogenation of coal has been carried out in Germany for several years, and in 1928 300,000 bbl. of gasoline were produced by this process. The plant being constructed in this country, while similar in principle to the German plant, will be used for the hydrogenation of fuel oils and heavy refinery residues to produce high-quality distillates. This process will be watched with a great deal of interest.

NATURAL GAS

There has been an enormous increase in the utilization of natural gas during the past year which has been brought about by the construction of long mains from the gas fields to various industrial centers. Certain of these lines are from 400 to 600 miles long, and a contemplated line from the Louisiana fields to Chicago will be even longer. The line construction has in almost all cases been steel pipe, using welded joints in the smaller sizes and Dresser couplings in the larger sizes. There has been some difficulty in changing over from manufactured to natural gas due to the fact that natural gas is essentially dry and therefore has a deleterious effect on the joints and meters of the typical system handling artificial gas. The difficulties have been overcome in several instances by supersaturating the gas with gas oil prior to its distribution through the city mains. The conservation of natural-gas resources has been the subject of much interest. Legal means have been taken to require the economic use of gas for repressuring oil fields. The biggest step in this direction has taken place in California during the past year, and is a distinct advance in the economic development of both gas and oil, with a minimum wastage of both.

MANUFACTURED GAS

During the past year there has again been a decided increase in coke-oven-gas production and a decrease in water-gas production. Data given by 96 typical gas companies indicate that for the first

five months of this year there was a 6 per cent decrease in water gas produced, a 12 per cent decrease in coal gas produced, a 39 per cent increase in coke-oven gas produced, and a 22 per cent increase in coke-oven gas purchased from coke and steel companies as compared with the corresponding five months of 1928. The total gas sold during these five months was 9.4 per cent higher in 1929 than in 1928, due largely to the increased use of gas for house-heating and industrial purposes.

There have been no outstanding new developments in the manufacturing field. The matter of dry quenching of coke and the dehydration of gas mentioned in last year's report are still very much in the limelight and are both apparently being received with increased favor. The Fort Wayne dehydration plant has now been in operation sufficiently long so that data are available, and the possibility of thereby producing non-corrosive, clean gas has awakened increased interest. A new dry-quenching plant is soon to be placed in operation at Flint, Michigan, which will be the second installation in this country. The original installation at Rochester has been in service three full years, and the results there have been very favorable. Considerable progress has been made this past year in the method of disposing of phenol from the coke-plant ammonia-still waste, and it is now possible to eliminate this source of stream pollution which has in the past been a very troublesome problem.

There has been a continual increase in the number of waterless holders for the storage of gas at relatively low pressures. The largest holder in the world, having a capacity of 20,000,000 cu. ft., which was recently placed in service in Chicago, is of the waterless type. Experience throughout the country in the use of these holders has been generally satisfactory. The use of high-pressure holders has met with increased popularity during the past year. Strategic location of these holders at points along the transmission line and at local distributing points has resulted in improved load factors on the transmission equipment.

Low Temperature Carbonization

In recent months a 600-ton-per-day K.S.G. low-temperature-carbonization plant has been placed in operation near New Brunswick, New Jersey, by the International Coal Carbonization Co. The semi-coke produced is being marketed locally as a domestic fuel, and the coal gas, mixed with blue gas, is sold to the Public Service Gas and Electric Corporation of New Jersey. Since this plant is the first of its type erected in this country and is moreover the largest of any type in the United States, much interest is being displayed in the results obtained. A similar plant of 50 tons per day capacity is under construction at Coatesville, Pennsylvania.

A "Lurgi" process plant having a capacity of 100 tons of briquets per day has been in operation at Lehigh, North Dakota, since December, 1928. It is adapted to North Dakota lignite and produces a carbonized-coal residue which is briquetted with pitch obtained from the process. So far it has given the results promised by the Lurgi Corporation.

Several experimental plants of other processes have been in operation during the year and have been more or less successful. It is reported that test work on the Carbocite plant at Philo, Ohio, has been completed, and that a commercial plant is to be designed. Plans are also under way for the erection of a Hayes process plant with a capacity of 400 tons per day.

Boilers

The outstanding point of interest in boiler development has been the radical increase in size as illustrated by the new units, each having a capacity of 800,000 lb. of steam per hour, which are to be placed in service at Hell Gate Station. These will supply steam for a 160,000-kw. turbo-generator, which is the largest single-shaft, single-unit generating machine in the world.

There has been an increase in the number of installations generating steam at pressures of 1200 to 1400 lb. per sq. in. Until recently high pressures have been used only for base-load conditions, but at least two high-pressure installations are now being erected which will operate at variable loads. In Europe pressures have gone much higher than 1400 lb. The Benson boiler, which generates steam at a pressure of 3200 lb. per sq. in., has been thoroughly tested experimentally, and large-size plants are being erected in England and Belgium.

The possibilities of using higher steam temperatures are attracting much attention. Practice in this country has not yet gone above 750 deg. fahr., but there are several experimental and semi-commercial plants in Europe which are operating at maximum temperatures of 900 to 950 deg. fahr. A plant in Belgium is operating commercially with a steam temperature of 800–825 deg. fahr. The Detroit Edison Company will shortly have in operation a 10,000-kw. turbine designed for an initial steam temperature of 1000 deg. fahr. The success of this experiment will be watched with interest.

There are said to be a number of boiler plants in Europe operating on the Löffler principle. A plant of this type at the Vienna Locomotive Works which generates steam at 1700 lb. per sq. in. and at 900 deg. fahr., has been in operation for about a year and has given satisfactory service. Improvements have been made in the Atmos boiler (described in Mechanical Engineering, vol. 45, p. 253, April, 1923), and a unit having a capacity of 26,000 lb. of steam per hour at 1400 lb. per sq. in. and 840 deg. fahr. is being erected.

Some experimental work on the development of drumless boilers has been carried out in this country, and it is possible that high-pressure boilers in future years will be of this type.

An interesting European development is the use of steam accumulators for handling peak loads in central power stations. An order has been placed for the installation of 16 accumulators at the Charlottenburg Station of the greater Berlin system. Each accumulator will be 14 ft. 9 in. in diameter and 69 ft. high, with a capacity of 11,000 cu. ft. The combined steam-storage capacity will be sufficient to generate 67,000 kw-hr.

Boiler Furnaces

The outstanding feature of the great majority of recent boiler installations is the almost universal use of furnace-wall cooling by means of air or water, with the trend apparently in favor of the latter. The reduction of refractory maintenance costs has been so marked that even the very expensive types of furnace-wall construction have proved to be good investments. At the same time the increased steaming capacity given by the extended radiant surface has reduced the fixed charges per unit of steam generated. In some cases, in which the furnace is entirely enclosed with water walls, as much as 40 to 65 per cent of the total heat in the steam is being absorbed by the water walls. Whether bare tubes or refractory-faced tubes are preferable is still a controversial question. Both types seem to be giving good service. In some cases both are used in the same furnace. In the latest pulverized-coal furnaces with bare tubes, blocks are being used for local protection against the effect of dripping slag. Facings of materials such as carborundum continue to attract attention because of their apparent ability to stand up under intense firing conditions.

The earlier expressed fears of incomplete combustion due to cooling of the reacting products have not been realized. The selection of the proper amount of water cooling to use in any particular installation has proved to be a question of economics rather than of combustion. Many stoker-fired furnaces are being equipped with local water-cooled-block-covered surfaces along the rear and side walls of the stoker. In the arched

furnaces with chain-grate stokers the water-cooled surfaces covered with high-quality refractory blocks have made a good showing when applied to arches and side walls. The troubles with the arch support have been largely eliminated.

During the development stage the water-cooled furnaces had to be fitted to standard boiler designs. With such combination many downcomers were necessary to supply water to the water-cooled furnace walls and many risers to carry away the steam. Strong efforts are now being exerted to so modify and simplify the furnace and boiler design as to greatly reduce the number of risers and downcomers.

Although the development of the slagging-ash type of furnace is a comparatively recent one, its adoption has been rapid, particularly during the past year. Fourteen furnaces so equipped are in operation, and twenty more are under construction. The furnaces for the high-capacity boilers under erection at Hell Gate Station are of this type. They have proved particularly applicable to the handling of low-grade fuels.

Another development which may prove applicable to the use of low-grade fuels is the mechanical gas producer applied to boiler furnaces. Experiments being carried out in this country have given gratifying results. It is reported that several commercial installations have been ordered in England.

Stokers

The time elapsed since the writing of the last report has been marked by a keener competition between stokers and pulverized-coal firing, the stokers regaining some of the lost ground. The development of stokers has taken place along two different lines, in each case being a result of commercial demands. Stokers for large units have advanced principally in size, while the smaller units have been made more convenient. To meet the new demands, stokers have been increasing in size rapidly. Underfeed stokers have been installed for units of 500,000 lb. per hr. steaming capacity, and the manufacturers are ready to meet any demand up to 1,000,000 lb. per hr. The chain-grate stokers have lagged somewhat behind the underfeed, principally because of the type of fuel which they handle. Coincident with increases in size there have been increases in the working combustion rates of all classes of stokers. At the present time the practical limit of combustion rates is often determined not by the stokers but by the slagging of boiler tubes.

The use of air preheaters as a final heat-absorbing medium is widespread, and consequently stokers have had to be adapted for use of preheated air. This has been done by using improved materials, allowing for structural expansion, and increasing the size of the air openings in the various types of grates. The maximum air temperature allowable for use with stokers depends to some extent upon the fuel used. Some coals have a tendency to fuse at comparatively low temperatures, obstructing the passage of air through the grates. In some cases an air temperature of 300 deg. fahr. has been found to be the maximum allowable on this score. In general, it has been found that stokers may be operated with an air temperature of 350 deg. fahr. with only a slight increase in maintenance. Certain improvements in the materials used for tuyères and grates permit running with 500 deg. fahr. air in some isolated cases. However, the average allowable air-temperature range is already sufficient for a proper proportioning of the heat-absorbing surfaces in a complete steam generator.

The flexibility of stokers as to the range of statisfactory combustion rates and types of fuel burned has shown a marked improvement. The timing device of one stoker allows a hundred-fold variation between the minimum and maximum rate of feed. The introduction of steam-turbine and hydraulic drives for stokers facilitates close regulation.

Concerning the types of coal burned by stokers, the progress made so far is closely connected with the furnace-wall construction and the temperature control effected by preheating the air on the one hand, and by water-cooled walls on the other. The overfire injection of air seems to be a success, especially with high-volatile coals. Small stokers developed for industrial boilers by many firms reached a high degree of efficiency and reliability of operation. Good practical results were obtained with an archless chain-grate stoker in which an early ignition of coal is secured from the grate bars upward. Many improvements in the mechanism and motion of the stokers have been effected, with the result that wear and tear is reduced.

The combustion efficiencies attained on stokers with improved draft distribution are excellent. With the deep ashpits the unburned carbon is reduced to a negligible amount—not higher than in the same size of pulverized-coal furnace.

Pulverized Fuel

Although recent improvements in stoker design have made possible the installation of large units, pulverized coal has proved more popular in most of the larger boiler furnaces. The new Hell Gate boilers, for example, which are the largest in the world, are to be fired with powdered fuel. This is due principally to the ease with which the pulverized-coal systems may be expanded, simply by multiplying the mechanical apparatus. An increase in size of stokers, on the other hand, generally means an entirely new design.

The storage and the direct-firing systems are now used both in central stations and industrial plants. The direct firing appeals strongly by its simplicity, especially for industrial plants where the steam-generating units are comparatively small, or where stoker-fired boilers are changed to pulverized coal. A number of central stations have also adopted the direct-firing system, and those plants that have been in operation for any length of time are obtaining satisfactory results. There are, however, few definite data available for comparisons of the economic performance of the plants using the direct-fired system with those using the storage system. There are still many engineers who prefer the storage system, at least for large installations, and they are able to present good arguments for their preference. In order to better compete with the direct-firing, the storage system is undergoing simplification. The driers are in most cases eliminated, and what drying is needed is done in the mill during the process of pulverization.

Although a great deal has been said and written about the possibilities of high rates of combustion of pulverized coal, the most practical rates are still between 1 and 2 lb. of coal per cu. ft. of total combustion space per hour, or, a rate of heat liberation of 12,000 to 25,000 B.t.u. per hr. There are a few exceptions where rates of heat liberation of 35,000 to 40,000 B.t.u. per cu. ft. of total furnace volume have been obtained, but such rates can be maintained only in water-cooled furnaces and with coals that have ash of a comparatively high fusion temperature. Generally the rates of heat liberation are kept lower on account of excessive erosion of furnace refractory and the slagging of boiler tubes.

In solid-refractory-wall furnaces and with coals of low ash-fusion temperature, rates of heat liberation of 10,000 to 12,000 B.t.u. are good practice; with coals having high-fusion temperature ash these rates are 14,000 to 17,000 B.t.u. In air-cooled-wall furnaces the rates are raised to 14,000 and 20,000 B.t.u. according to the fusion temperature of the ash. In water-cooled furnaces rates of 25,000 to 35,000 B.t.u. are practicable, provided that proper precaution has been taken to minimize the possibility of slagging the boiler tubes and stopping the gas passages through the boiler. Generally speaking, in smaller water-cooled furnaces the rates can be higher than in larger ones,

because the ratio of water-cooled surface to combustion space is greater and the products of combustion are cooled to a greater extent by the time they enter among the boiler tubes, and there is less tendency for the ash to be deposited on the boiler tubes and stop the gas passages.

The above-mentioned rates of heat liberation are the average of the entire furnace volume. Near the burner where the combustion is very rapid the rate may exceed 100,000 B.t.u., while in the space near the boiler tubes it may be less than 1000 B.t.u.

There are three methods of firing in general use, namely, vertical firing, horizontal firing, and corner or tangential firing.

Vertical firing was the first to be developed, and many of the large plants burning pulverized coal are using this method. In most of the first installations only the primary air was supplied under pressure; the secondary air was drawn into the furnaces at low velocities through air ports in the front wall by the furnace draft. In more recent installations, and particularly where air heaters are used, the secondary air is supplied under a pressure of 1 to 2 in. of water, making it possible to admit the air into the furnace at high velocity. Part of the preheated air is also supplied under pressure through the burner bodies around the fuel nozzles. The air pressure and the resulting higher velocities produce intensive mixing and rapid combustion.

Horizontal firing is gaining in favor. Usually its installation is more simple and somewhat cheaper than that of vertical firing because no furnace arches are necessary. The burners are placed in the front wall, and generally all the secondary air as well as the primary air is supplied through the burner under a pressure of 2 or 3 in. of water. While passing through the burner the mixture of primary air and coal and the secondary air are given a somewhat rotary motion, which produces turbulent mixing in the furnace. These rotative burners are built in capacities of 2000 to 8000 lb. of coal per hr. Certain of these burners are adjustable so that the cross-section of the air passages can be decreased when the amount of coal to be burned is reduced, in order to make it possible to maintain fairly high velocities and good mixing.

In a few installations two sets of these burners are used, one in each of two opposing walls, so that the flames from the two sets meet in the middle of the furnace and produce intensive mixing. This is called "opposed horizontal firing," and it is especially well adapted to large units with deep furnaces in which it would be difficult to install enough burners in one wall and fully utilize the available combustion space.

In the tangential method of firing, streams of the mixture of coal and air are projected horizontally from the four corners of the furnace toward the center in such a way that the streams are tangent to a small circle in the center of the furnace. Preheated secondary air is supplied under a pressure of 2 to 4 in. of water around the burner nozzles in the same direction. The streams of coal and air impinge against one another and produce intensive mixing and rapid combustion. The furnace gases move in a helical path toward the gas exit from the furnace. This helical flow maintains the turbulence and rapid combustion. Rates of heat liberation as high as 40,000 B.t.u. may be obtained, with satisfactory results as to efficiency and continuity of operation. Inasmuch as the flames are confined by the furnace walls in their helical path, there is considerable impingement of the flames against the walls. Therefore tangential firing can be applied only to completely water-cooled furnaces. Refractory furnace walls would be rapidly wasted away.

A number of installations with tangential firing have been put in service during the last two years and show the highest rates of heat liberation of any of the powdered-coal plants so far installed.

Most of the pulverized-coal installations are designed for the removal of refuse deposited at the bottom of the furnace in granular form. In such installations the deposited ash is prevented from fusing by a water screen placed over the bottom of the furnace or by a water-cooled furnace bottom.

As mentioned elsewhere, a number of installations have been made within the last two years in which the ash deposited at the bottom of the furnace is fused and removed in the liquid state. A spray of water is generally used to chill and disintegrate the molten ash into granular form. The disintegrated slag is pumped away in suspension.

Inasmuch as no refractory will stand the erosive action of molten slag, it is essential for low maintenance that the walls of the furnace be completely water cooled. On the first installations of slagging furnaces it was thought necessary to protect the furnace bottom with a layer of dolomite sand. Experience with more recent installations indicates that this is not necessary, provided that the tapping hole is not less than about 10 in. above the brick lining of the furnace bottom.

The slagging furnace is especially well suited for burning coals with very fusible ash. If the ash is of high fusion temperature the burners should be located so as to cause the flame to impinge against the refuse collected at the bottom of the furnace, heating the refuse to as high a temperature as possible.

Roller mills and ball mills are more extensively used for pulverization than other types, because they pulverize coal to a high degree of fineness, have high capacity, low power consumption, and low maintenance. They are built in capacities up to about 40 tons per hour. In the past they have been used almost entirely in installations using the storage system, but within the last two years they have been applied to direct firing with considerable success. It appears that in the future they will be used extensively for direct firing of the larger-size steam-generating units. They are now built with a continuous system of lubrication, and can be kept in operation indefinitely.

High-speed impact mills are used largely for direct firing of small and medium-size units. They are particularly well adapted for installations where the space available for mills is small. Being of high speed, they have a high capacity for their size. They are also less sensitive to the flow of air with variable output. However, the fineness of the coal is less constant with variable output and the maintenance is somewhat higher than with the roller and ball types of mills.

The ball or tube type of mill is used for milling anthracite, coke, and other hard and abrasive fuels, and in cases where extreme fineness is necessary. While with such hard and abrasive fuels the mill maintenance with other types of mill would be prohibitive, it is comparatively low with the ball- or tube-type mill. The tube mill being a machine of a very low speed, its size is large for a given output. It is used for direct-firing as well as for storage systems.

The fineness to which a coal should be pulverized is a controversial question and varies with the character of the coal and the size of the furnace in which the pulverized fuel is to be burned. The higher the fixed carbon content, the higher the fineness to which the coal should be pulverized. Thus, according to one authority, coke and anthracite should be pulverized to a fineness of 80 or 85 per cent through 200-mesh screen; Pocahontas and New River to 70 to 75 per cent, Eastern bituminous coal to 65 or 70 per cent, Illinois to 50 to 55 per cent, and Texas and North Dakota lignite to 40 or 45 per cent through 200-mesh screen.

In cases where the furnaces are of necessity very small, as in marine and locomotive boilers, all coal should be pulverized very fine to obtain satisfactory combustion results. A fineness as high as 80 per cent through 300-mesh screen is believed necessary for Scotch marine boilers.

The principal developments in pulverized-fuel burning during the past year are not so much improvements of the methods in

use in central stations, but rather the adoption of powdered-fuel firing to other equipment. Experiments have continued on the problem of the marine use of pulverized fuel, and in most cases have been highly successful. Several ships were equipped during the past year and have given gratifying results. One vessel, three of whose six boilers were fired with pulverized coal, completed a voyage of 11,000 miles during which five kinds of coal were used with entire success. The results were so satisfactory that the remaining three boilers are to be equipped for burning pulverized coal.

The application of powdered coal to locomotives has apparently been successful in Germany, and at least one locomotive in this country is so equipped. There has been a growing interest in the use of pulverized coal in industrial furnaces of various kinds.

Much has been published recently concerning the use of pulverized fuel in Diesel engines. Although the idea is by no means new, the mechanical problems have in the past resisted solution. However, several European investigations have recently brought out designs which are said to be satisfactory and may prove to be popular.

Fuel Oil

With the continued overproduction of petroleum the price of fuel oil has remained low, and this fuel has become increasingly popular for certain classes of service. Partly as a cause of and partly as a result of the growing popularity of oil, there have been major improvements in burner design, and there has been a decided tendency on the part of the fuel user to adopt the more modern equipment. The home-made burner of pipe fittings which required large quantities of steam and still gave unsatisfactory atomization, is being replaced by more efficient steam atomizing burners and by mechanical atomizing burners which can be adjusted to give the type of flame desired with a minimum of excess air.

Diesel Engines

The greatest advance in this field during the past year has been in connection with the use of high-speed Diesel engines. Increases in speed and decreases in weight per horsepower have made possible new and interesting applications. Experiments have been made with a Diesel-motored airplane, and a plane so equipped was actually flown for several hundred hours. Investigations of Diesel-powered trucks have continued and give promising results. In Germany they have been in use for several years, and more than 100 are in regular service.

A recent development in the field of large Diesel engines is their use in central power stations to handle peak loads. Several European systems are now installing them for this service, but it is probable that their high first cost will preclude their rapid adoption for peak loads in this country.

Locomotives

It has been reported recently that an oil-burning locomotive of the Kansas City Southern Railroad has been equipped with a unit system of pulverized-coal firing and has given excellent results. It is stated that the fuel consumption is 25 per cent less than with a similar hand-fired furnace, and that the steaming capacity is equal to that of an oil-fired boiler. The fuel cost is only 40 per cent of the cost of oil firing. The coal fed to the pulverizer is 1-in. slack, costing only about half as much as run-of-mine.

Other than this there have been no fundamental innovations in the design of locomotive furnaces or spectacular reductions in fuel consumption in this country during the year. Superheaters, brick arches, thermic siphons, and mechanical stokers continue to be applied as a matter of course, but there have been no radical changes in their designs.

There has been a continued and perhaps an increased interest in the proper preparation of coal for locomotives and in delivering it on the tender in good condition. This last purpose has entailed some novelties in the design of coal chutes. Within the past four or five years there has been a considerable revival of interest in the design of locomotive grates, and this has received additional attention during the past year.

There continues to be a determined effort to make use of poorer grades of fuel where it is easily accessible, as, for example, the utilization of lignite in Texas and in the Northwest. On certain railroads this effort has been recently intensified.

In Europe the developments have been more radical. In addition to the Schmidt and Löffler-principle locomotives mentioned in last year's report, there is now under construction a turbo-locomotive the steam for which will be furnished by a Benson boiler under a pressure of 3300 lb. per sq. in.

Industrial Furnaces and Power Plants

There has been a noteworthy improvement in industrial fuel economy during the past year, particularly in the steam-generating end. There has been a decided attempt in the building of new units to select a pressure such that a proper balance is obtained between heat and power requirements. Several industrial plants have selected the present upper limit of American practice as the boiler pressure best suiting their requirements. In fact, one industrial boiler plant now being erected is intended to operate at 1800 lb. per sq. in., which will be the highest steam pressure in use in this country. Plant executives are waking up to the importance of fuel economy and are making much-needed improvements.

Heat-treating furnaces of various kinds have shown improvements recently. There is a strong trend in favor of continuous furnaces with automatic control. Insulation is being applied to a greater extent, although there are many cases where the high temperature level of the operation precludes the possibility of insulation without undue deterioration of the refractories. There continues to be a greater use of the fuels which lend themselves to ease of handling.

Domestic Heating

The demand of the householder for liberation from the drudgery of furnace tending is determining the developments in the field of domestic heating. There has been a great increase in the number of oil burners installed, and gas-fired furnaces also have had a steady growth. There are some isolated installations of electric house heating in which off-peak power is used.

The competition from gas and oil has caused the development of the domestic stoker designed for burning small sizes of anthracite and bituminous coal. During the past year these stokers have been improved, and many new designs have appeared which have been more or less successful. The major drawback to the general adoption of domestic stokers, not considering the fact that they require more attention than oil- and gas-fired furnaces, is their inability to handle all classes of coals. It is sometimes difficult or impossible for the householder to obtain the type of fuel for which the stoker was developed, and there are often great difficulties in attempting to burn coal for which the stoker is not adapted.

Refractories

Although the manufacture of refractories is not altogether a problem of fuel utilization, still refractories are such an important part of most combustion equipment that a short summary of the developments in this field will not be out of place.

During the past year there has been a general adoption of manufacturing methods in refractories which, while not entirely

new, would have been considered revolutionary several years ago. The tunnel kiln has been adopted for burning fireclay, silica, and chrome brick, and many labor-saving devices have been installed. Several new refractories have come into prominence recently, among which are unburned magnesite brick, mullite, sillimanite, and refractory shapes made from a mixture of chrome and diaspore. Diaspore refractories which have been subjected to an unusually high heat treatment are available commercially, and development work is being carried out on the manufacture of light-weight cyanite brick which combine heat-insulating properties with high refractoriness. Progress has been made in the design of special refractory shapes for blast-furnace stoves and open-hearth regenerators. The new shapes are said to result in large gas savings.

Considerable research on the failure of refractories in service is under way in various laboratories, and studies are also being made on various phases of manufacturing methods.

RESEARCH

Fuel-research activities have shown a notable increase during the past year, both abroad and in this country. The subjects on which work is being done seem to cover almost the entire field, but unfortunately in the United States there is very little coordination of effort. There is a certain amount of cooperation between various professional societies, but this country has no really sound fuel-research program.

In spite of the handicap, however, research is going on and valuable results are being obtained. An important activity started two years ago and which is continuing is the study of the coking and gas-making properties of American coals conducted by the American Gas Association in cooperation with the United States Bureau of Mines.

The research projects sponsored by the American Petroleum Institute are being carried on by a large group of investigators located in various educational institutions throughout the country.

The subject of pulverized coal is receiving more attention than ever before; particularly its combustion and use, and including also the economics of pulverized coke as a fuel.

The work of the coal-classification committee of the American Society for Testing Materials, which work involves both pure and commercial research, is being continued and good progress is being made.

The fuels-research work of The American Society of Mechanical Engineers is being reorganized. A general conference of leading engineers and chemists was held in October for the purpose of considering and recommending subjects, plans, and methods.

Research work of the National Coal Association is progressing principally in the direction of marketing, distribution, and use.

During the year the Anthracite Operators' Conference has started studies of domestic heating appliances and the factors influencing their performances.

The United States Bureau of Mines, in cooperation with The American Society of Mechanical Engineers, has done a great deal of work on refractories and on the slagging-ash type of furnace. The Bureau is also resuming its study of brick kilns in cooperation with the University of Ohio.

Some of the university laboratories have made important contributions during the year and are continuing their efforts.

In general, it may be said that there is more fuel research now in progress than at any previous time, and the outlook is encouraging in spite of the handicaps. It is interesting to speculate as to what might be accomplished by an amply financed organization devoted to the cause of fuel research. It is to be hoped that such a speculation will not be altogether an idle one.

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T. A. MANGELSDORF.[1]

Progress in Hydraulics

Contributed by the Hydraulic Division

Executive Committee: L. F. Moody, *Chairman*, B. E. White, *Secretary*, H. L. Doolittle, W. M. White, and Ely C. Hutchinson

MUCH the greater part of the developed and undeveloped water power of the United States and Canada is owned by public-utility companies. For this reason, the consolidation of electrical service and holding companies into fewer and larger business organizations is a development which vitally affects the field of hydraulic engineering, because it affects the economics of hydroelectric power. These effects are both favorable and unfavorable.

The much wider, and possibly almost universal, adoption of the so-called promotional or inducement form of rate, together with the probability of uniform rates for different classes of service throughout areas of considerable size, will accelerate the demand for electrical service, thus creating a much larger market to be supplied.

On the other hand, the much larger and more economical fuel power stations made possible by the consolidated utility groups and the greater demand, have changed the load conditions and lowered the unit costs of energy to a level with which many water powers can no longer compete.

FACTORS AFFECTING THE ECONOMICS OF HYDROELECTRIC POWER DEVELOPMENT

One of the major effects of the increasingly large combinations of utility companies has been upon the economics of many water-power sites, which had hitherto been considered favorably for development. With the vastly increasing markets, the load factor demanded from many sites and plants has been profoundly changed, while at the same time the construction of vastly larger and much more efficient fuel power-generating stations has resulted in a lower competitive cost which many water-power sites cannot meet. A partial solution of this difficulty may possibly be found in a simplification of hydroelectric construc-

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tion, which may result in lower construction and operating cost. The automatic and semi-automatic plants are types of the tendency in this direction. Likewise, the outdoor or semi-outdoor type of hydro generating station, consisting of one or more units remotely controlled, either from another power station or by variations in forebay water level, are variations of this tendency.

The discovery and development of an important natural-gas field in central California has made it possible to produce steam power in gas-fired installations at a lower cost than previously obtained with oil-fired boilers and many hydroelectric plants. In the opinion of many on the Pacific Coast, it is probable that new hydroelectric developments in that region will be greatly retarded, if not nearly discontinued, for a period of years by this development.

Contrasting with the opinions of some as to the economics of hydro power versus steam power, is the situation reported in the Pennsylvania area, where with all its coal mines a four-fold increase in hydro power installation has taken place within the last six years. Apparently there is still a field for the skilful hydroelectric engineer who makes his designs on the basis of dollar efficiency.

Ample water-storage capacity is becoming an ever more necessary adjunct of commercially efficient hydroelectric development, and many sites heretofore considered unavailable are constantly being found to be commercially feasible.

There is said to be an increasing tendency to purchase hydraulic equipment on the basis of price alone. It seems hardly necessary to call the attention of engineers to the fact that there is still room for advances in design and construction, which can only be brought about by continued study and experiment, at some one's cost. In this field the logical source of such experimentation is the manufacturer. Price cutting below the level of a fair profit will inevitably dry up these springs from which improvements flow, and at the same time introduce the hazards that go with poor design and construction, and details slighted or omitted to save cost, with consequent lessened efficiency and increased maintenance costs.

The outstanding tendency is to build larger and larger units, limited only by the quantities of water available from season to season, or by the limitations of mechanical design or of transportation. This has been made commercially feasible by the larger markets, and by the large aggregations of available capital resulting from the great groupings of utility organizations which have recently been brought about and are still continuing their growth.

Governmental Regulation and Supervision of Utilities and Structures

There are many who view with concern the increasing burden constantly being thrust upon utility concerns, who are by far the largest aggregate owners of water powers, and upon water-power development in particular, through the medium of legislation and administrative regulation. The margin of cost between fuel-generated and water-generated power and energy in nearly all parts of the country has been cut to such small dimensions that the taxes and license fees recently imposed have made the development of additional water power almost, if not quite, a hopeless proposition, so far as competition with steam-, oil-, or gas-generated energy is concerned.

The public authorities, as represented by the state engineers, etc., are exercising a greater degree of control and supervision over the design and construction of high dams than ever before, as a result of such failures as that of the St. Francis Dam.

Governmentally Owned Hydro Plants and Projects

During the year, the largest hydro power development thus far projected, that at Boulder Canyon, on the Colorado River, has been authorized. In connection with it there will be constructed the highest dam in the world, impounding probably the largest artificial body of water in existence. The construction of this project involves many difficult problems of engineering design and construction, as well as many problems arising out of its ownership, construction, and operation by the Government, the sale of its output to utility companies, municipalities, etc., and the transmission of the energy output to great distances.

The disposal of the Muscle Shoals power plant, or of the energy thereby produced, is still under consideration. Likewise the status of the combined St. Lawrence River power and navigation development is practically unchanged, with little to indicate that any definite steps will be taken toward its construction at an early date.

Model Testing

Turning to the more technical field, the subject of model testing, or the experimentation with small models of proposed conduits, machines, or structures, received a great impetus through the publication of John R. Freeman's book on "Hydraulic Laboratory Practice." This monumental work has brought the subject and its possibilities vividly to the attention of many engineers and executives who have hitherto not realized them. It is not surprising, therefore, that model testing, on a greatly accelerated scale, is now going on.

An increasing use of model testing is being made in the investigation and design of the water passages leading to turbine units. Many power companies are finding it well worth while to investigate the possibilities of variations from the accepted forms of intakes and water passages, or those designed by the ordinary rule-of-thumb method, as in the past. In some cases very large savings in earth or rock excavation have been made. In others, more efficient structures have been produced with the same volumes of masonry, or equal efficiency obtained with structures of decidedly less cost. These tests have also revealed the surprisingly large influence of small bends, and other variations in cross-section and alignment, upon the efficiency of the units, the elimination or alteration of which paid very handsome dividends upon the cost of the tests.

Mr. Freeman's book having been written primarily to describe the numerous European laboratories and their methods, and in advocacy of an American national hydraulic laboratory, it is perhaps natural that many received from it the impression that the laboratories in this country are decidedly inferior. It is undoubtedly true that there are but few of them which are equipped to carry on many of the investigations now being regularly made across the Atlantic. It is fair to say, however, that there are in this country laboratories which possess every requisite for the making of any type of hydraulic experiment for which any probable need may arise.

At least one of the university laboratories has been engaged for a considerable length of time in making experiments involving river hydraulics, and more particularly in developing suitable spillways, energy-dissipating devices, channels, etc. A particularly large model of a section of approximately $1^1/_2$ miles of the channel of the Columbia River, at, above, and below Rock Island, has been constructed at the Alden Hydraulic Laboratory, Worcester (Mass.) Polytechnic Institute, and experiments are now being made to determine the best type of dam, number of gates, etc. to effectively control the flow at high flood stages.

While the discussion of the proposed National Hydraulic Laboratory is continuing and little apparent progress is being made, various universities and governmental and private laboratories have been newly established or have been expanding their facilities. Some have expressed the belief that the parceling

out of important studies among laboratories scattered throughout the country would exercise a profound influence for good upon the practice of hydraulic engineering. It is held that the much wider dissemination of the knowledge of and experience in model testing and its relation to the results with full-sized structures will stimulate research and accelerate the discarding of time-honored, rule-of-thumb methods of design.

In the field of model testing also, a method has been worked out by the engineers of the U. S. Reclamation Service, Denver, Colo., for the design of arch dams by the trial-load method. This is the first method thus far proposed in which the shape of the canyon is taken into consideration in the determination of stresses.

This is, no doubt, a direct outcome of the work of Engineering Foundation's Committee and associates at the Stevenson Creek arch dam, California, and of the corresponding model-arch tests made by Professor Beggs, of Princeton University.

Dams and Accessories

In the recent past, what had been considered minute and unnecessary details of dam construction have been receiving the attention that they deserve. It has been realized that contraction joints should be provided in at least two directions in massive unreinforced concrete masonry, in order to avoid possibly dangerous cracking. New methods of placing concrete, notably the use of articulated belt conveyors and towers, have recently been introduced, thus avoiding the horizontal flow of concrete and the segregation of material. Likewise, the water-cement ratio need no longer be influenced by the consideration that the mixture should be plastic enough to flow readily in chutes.

Recent investigations by means of telemeters imbedded in large concrete masses, such as dams, have revealed the existence of high local temperature stresses. Investigations in regard to this matter are now in progress at the Shaver Lake Dam, in southern California, and at Bull Run Dam, in Oregon.

The use of electric-arc welding has been extended to the construction of racks and gates of various types, producing structures of better design and greater strength and resistance than were heretofore obtainable with the usual bolted or riveted connections.

The increasing use of the controlled spillway instead of the formerly almost universal fixed spillway has also resulted in a marked reduction in the cost of many projects. A particular advantage is that of avoiding the occasional flowage of large areas of land, at times of flood, which are normally free of water, thus reducing the cost of flowage land and the damages from flooding.

Measurement of Water

There is also reported a markedly increasing tendency among power companies to have their units tested for efficiency under operating conditions. There is also a rapidly accelerating tendency to rate some hydraulic section adjacent to each unit for use in connection with a flow recorder, so as to be able to maintain a continuous record of water flow for comparison with electrical output, as a check against efficiency, and also to maintain a continuous record of stream flow. The latter element is often of very great importance, since the construction of many hydro plants drowns out the excellent gaging stations maintained under the supervision of the U. S. Geological Survey or state engineering departments, thus causing the loss of all reliable means of measuring the flow of the river.

Where the units are equipped with flow recorders, the forebay with a water-level recorder, and in addition a record is kept of spillway-gate or flashboard openings, it is possible to duplicate with reasonable accuracy the records formerly kept at river-gaging stations. The value of these records in checking station performance, as well as in planning future development, is hard to estimate.

In the field of pure hydraulics there should be mentioned the Parshall venturi flame developed by Ralph L. Parshall, Mem. A.S.C.E., of the U. S. Department of Agriculture, Fort Collins, Colo., for the measurement of the flow of water in open channels. This flume is extremely simple, as well as very accurate. Mr. Parshall has also conducted valuable experiments for the determination of the relation of the evaporation from large water surfaces to that from various kinds of evaporation tanks.

Adjustable-Vane Turbines

In the field of hydraulic machinery, the most notable development of the past year has been the installation at the Devil's River plant, in Texas, of a Kaplan-type high-speed turbine, whose blades are adjustable by means of the governor. A second unit of this kind is to be installed by the Wisconsin Power & Light Co. at their Rockton Plant, and several additional units are now being built for the Nova Scotia Power Company. High-speed runners, with hand-adjustable blades, had been previously installed at the Chippawa Falls Plant of the Northern States Power Company, and more are being installed by the Dominion Engineering Works, Ltd., Montreal, a subsidiary of I. P. Morris & De La Vergne, Inc., in the Back River project of the Montreal Power & Light Company, near Montreal, Canada, as well as at the Upper Hook Falls development of the Nova Scotia Power Commission. Two of the Back River units have been built with ejectors, which are expected to increase the output of the machines approximately 1000 hp. each during periods of high water. This type of installation permits a much more efficient use of a variable flow on a variable head than turbines with fixed vanes, and will undoubtedly have a marked effect upon the economics of many low-head, run-of-river projects.

High-Speed Propeller-Type Turbines

The successful application of propeller-type turbines to heads as high as 60 ft. has been demonstrated by the installation of a fifth 28,000-hp. I. P. Morris unit in the Great Falls plant of the Manitoba Power Company. Here the head varies from $17^1/_2$ ft. to 60 ft. Control of cavitation was secured by providing sufficient blade area to give liberal values and distribution of pressure intensity.

Impulse Turbines

In the field of impulse turbines, improvements have been made in their efficiency by improving the shape of the buckets and nozzles, and by the addition of baffles to prevent water from entering the housing.

There has recently been put into operation an impulse turbine of 32,200 hp., at 143 r.p.m., under 800 ft. head, of the double overhung impulse type. The impulse wheels are each 176 in. in diameter, or 21 in. greater than that of the largest previous units. The jets impinging on the buckets are 14 in. in diameter. This unit was installed by the Allis-Chalmers Company, Milwaukee, Wis., in the San Francisquito No. 1 Plant of the Bureau of Power and Light of the City of Los Angeles, Cal.

In the Big Creek No. 2-A plant, of the Southern California Edison Company, two double overhung single-nozzle impulse units of 56,000 hp. capacity, under 2200 ft. head, were installed, one by the Pelton Water Wheel Company, San Francisco, Calif., and the other by the Allis-Chalmers Company. These machines are of record capacity for this type of turbine, and have developed a maximum of 70,000 hp. each over long periods.

The Pelton Water Wheel Company also installed two 35,000-hp., double overhung impulse turbines at the Bucks Creek plant

of the Feather River Power Company, where an efficiency of 85.05 per cent was obtained. Maximum outputs of 40,000 hp. have been developed.

Active experimentation is being carried on by the Allis-Chalmers Company and the Pelton Water Wheel Company, with the object of still further increasing the efficiencies of impulse units.

Reaction Turbines

During the year, the highest-head plant in the East was placed in operation: namely, the Waterville Plant of the Carolina Power & Light Company, at Waterville, N. C., operating under 861 ft. head. The principal features of this plant are a constant-angle arch dam 180 ft. in height, a 14-ft. tunnel drilled in solid rock, approximately 6 miles in length, and the use of reaction turbines of 33,500 kw. each.

A 44,000-hp. Pelton turbine, operating under 715 ft. head, was installed in the Southern California Edison Company's Big Creek No. 8 plant, which showed a maximum efficiency of 93 per cent when tested by the Allen salt-velocity method.

Among the interesting reaction-type units may be mentioned the 8550-hp. unit being constructed by I. P. Morris & De La Vergne, Inc., for the Turners Falls Power and Electric Co., for its Cobble Mountain, Mass., development, to operate under 420 ft. head. This unit will operate in connection with a long pipe line and, to limit pressure rises, the rate of gate closure will be limited by non-removable diaphragms in the governor piping instead of a relief valve. Leakage and waste of water through relief valves will be eliminated and the pressure rise definitely limited by a simple device.

Rubber sealing strips, set into the faces of the upper and lower distributer rings, against which the guide vanes tightly close, are a feature of two 36,000-hp. units, to be installed at the Alabama Power Company's Lower Tallassee development, under 88 ft. head. These strips reduce the gate leakage during the hours when the units are shut down, leaving them in condition for immediate starting up in case of necessity by simply opening the guide vanes, yet economizing the water supply.

Rubber-lined bearings have also proved successful in a number of large units. Bearings $22^1/_2$ in. in diameter are installed at the Back River plant, Montreal, Canada.

Extensive research in the field of reaction turbines and related structures, such as conduits, draft tubes, etc., is being steadily carried forward in the excellent laboratories of turbine manufacturers, universities, and power companies. As this research proceeds, new and valuable testing equipment and methods, as well as important improvements in and data concerning turbines and accessories, are constantly being developed.

Recent advances in electric-arc welding have made it possible to produce arc-welded plate-steel scroll cases, some of which have been constructed with short, straight tangential sections, and some with bumped plates, which combine the interior smoothness and streamlines of cast-metal scroll cases with the strength and ductility of steel. The very much lighter weight obtainable with sheet-metal cases is reflected in the ease and reduced cost of transportation, and also undoubtedly eliminates the hazard of cracked scroll cases, which have been responsible for a number of serious accidents in hydro power plants.

This type of spiral case has been used by the Allis-Chalmers Company, with two 56,000-hp. vertical units, under a normal effective head of 213 ft. having 16-ft. inlet diameters, and for three 36,000-hp., 390-ft.-head turbines, the latter having been installed in Japan. The flow of water to both of these units is controlled by electric-motor-operated butterfly valves. Other companies have also built turbines with welded-steel scroll cases.

One contributor emphasizes the importance of the satisfactory operation of the Oak Grove, Oregon, 850-ft.-head reaction units as a measure of economy. The space requirements for such a unit are much less than those for impulse units of the same capacity, under the same head, thus economizing in the cost of power-house construction. These and other high-head units have now been in operation for approximately five years, with very satisfactory results, thus confirming the practicability and reliability of high-head reaction turbines, concerning which some doubt was felt at the time of installation.

During the past year the Rocky River pumped-storage hydro development has been put into service and has functioned satisfactorily.

Generators

The development of the umbrella-type generator, at the instance of A. C. Clogher, hydraulic engineer of the Electric Bond and Share Company, has made it possible to reduce the height of power houses. This type of generator requires but two bearings, the upper a combination thrust and guide bearing, and lends itself to the semi-outdoor type of installation in which a conical hood of sheet metal protects the generator from rain entering at the top, and at the same time permits ventilation to the outdoor air.

In one installation at least, the Norwood Station of the Carolina Power & Light Co., Mt. Gilead, N. C., air washers have been installed adjacent to the generators, not only to remove the dust in the air, but to cool it to such an extent that better ratings and better generator efficiencies are obtainable in hot weather.

The recently developed Kingsbury spherical combined thrust and steady bearing seems to offer possibilities in connection with this design of unit.

Frequency and Load Control

The widespread interconnection of power systems which has occurred in recent years has made the regulation and maintenance of frequency of vastly increasing importance. There have been developed at least two systems of frequency control which have produced very satisfactory results: namely, the apparatus developed by S. Logan Kerr, of I. P. Morris & De La Vergne, Inc., in cooperation with engineers of Leeds & Northrup, and that of the Warren Telechron Company, both of which have been used sufficiently to demonstrate their value.

I. P. Morris-Leeds & Northrup have also developed a load-control apparatus which has functioned satisfactorily to regulate the load carried by two or more units in a station, in order to maintain the highest efficiency upon a given number of units for a given superimposed load. Savings of as much as 8 per cent in energy generated were disclosed by comparative tests with the use of this apparatus, and with the usual methods of hand regulation. The satisfactory operation of this apparatus at the Norwood plant of the Carolina Power & Light Company, has led to its installation at a number of other plants.

Penstocks

Improvements have also been made in the design and materials of penstocks and other accessories for conveying water to the turbines. There is a notable tendency to use welded pipe, especially in Europe where welded bell-and-spigot joints are being extensively utilized. European, and some American, engineers are using welded stiffening angles and other types of reinforcement for penstocks, wyes, branches, etc., increasingly. Anchorages of welded structural steel are also being used to a greater extent.

Improvements in welding equipment and procedure, the recently developed method of non-destructive testing of welded

joints, and the improvement in the quality and strength of welded work are creating increased confidence in pipes and special fittings of welded construction. Their greater interior smoothness, the flexibility, ease and speed of design and construction, and their lower cost will undoubtedly bring about a much wider use of water conduits of this type.

Pumps

Research is continuing in the field of centrifugal and screw-type pumps, as is demonstrated by the papers presented before the Society. High-speed propeller-type pumps are growing more popular. Four Moody spiral pumps, of 70,000 g.p.m. capacity, at 400 r.p.m. under 26 ft. head, have been installed by I. P. Morris & De La Vergne, Inc., for the Robins Dry Dock and Repair Company, in New York.

Fish Screens and Fishways

Electrified fish screens have been the subject of intensive and successful experiment in the Northwest during the past year. Their efficacy in preventing fish from traveling into channels where they are unwanted has been proved beyond a doubt, as practically none were found to have passed through them. Further experiments in the way of using them to direct fish to fish ladders or fishways are under way. Likewise experiments on the various types of fish ladders or lifts and other devices for controlling the movements of fish with safety to the finny tribe, are under way, with promise of success. A reasonably satisfactory solution of this problem will remove a very large part of the objection to the construction of high dams on the Pacific Coast, and elsewhere, where anadromous or migratory fishes are present.

Hydrology

In the field of hydrology, promising advances have been made in predicting annual and even seasonal run-off by the use of cyclic methods applied to widely separated drainage areas whose hydrological conditions and topography are much unlike. Attempts to find definite relations between the volume of precipitation in a given rainfall and the succeeding flood peak and run-off, appear to hold some promise of success. A statistical method of relating annual rainfall and run-off has also been developed, whose preliminary trials on watersheds of different characteristics have given very close results. This, combined with the cyclic analysis and forecast of stream flow, holds much promise of furnishing a reasonably close approximation of past run-off where rainfall records exist but stream-flow records are absent; and also of forecasting the flow for the next season and year. With accumulating knowledge and experience, and an increasing number of investigators, further progress along these lines should be rapid.

Progress Report Committee, Hydraulic Division.

Progress in the Iron and Steel Industry in 1929

Contributed by the Iron and Steel Division

Executive Committee: C. Snelling Robinson, *Chairman*, F. C. Biggert, Jr., Walter Trinks, and W. W. Macon

Technical progress in the iron and steel industry in 1929 has been rather unusual, and there is every indication that much greater advances will be made from time to time because of the intensive study that is being prosecuted in our research laboratories and the practical application of the results thus obtained. In order for steel companies to keep in a fairly competitive position it is necessary to make a determined effort to utilize all of the technical developments possible. This is no time to be satisfied with present processes, nor to take the attitude that there is no further improvement to be made.

While, in general, the selling prices of materials have not greatly increased, earnings have been much better owing to economies which have been effected in the course of production and to the careful attention given to methods used. Much of the decrease in the cost of production has been brought about by large investment in new machinery and plant facilities. The output of steel products has increased greatly, largely due to the same causes rather than to the building of new mills.

The tendency toward mergers with a view to decrease in overhead and to general economies of production has been evident in the iron and steel industry as well. Among the important moves of this kind may be mentioned the following. For the first time in many years the U. S. Steel Corporation has absorbed an existing steel mill by taking over the Columbia Steel Company with plants at Pittsburgh, Calif., and elsewhere on the Pacific Coast, apparently in an effort to provide that growing region with locally made material. A merger of the A. M. Hanna properties, the Weirton Steel Company at Weirton, W. Va., and the Great Lakes Steel Corporation with a plant under construction in the Detroit region, has resulted in the formation of the National Steel Company. The Central Alloy Steel Company, formed some two years ago through a merger of the Central Steel Company, of Massillon, Ohio, and the United Alloy Steel Company, of Canton, Ohio, has absorbed the Interstate Iron and Steel Company in Chicago, which makes it one of the most important alloy-steel producers in the country. The control of the Donner Steel Company has passed to Cleveland interests headed by C. S. Eaton, and this has been followed by an amalgamation of the Donner Steel Company with the Witherow Steel Company. The Republic Iron and Steel Company first acquired the Steel Tubes Company, which gave it control of important patents for the manufacture of electrically welded pipe, for which purpose a new plant has been erected at Warren, Ohio. This was followed by the acquisition of the properties of the Union Drawn Steel Company, in Massillon, Ohio, Beaver Falls, Pa., and elsewhere. The papers have repeatedly announced that a tremendous merger was under way involving, according to some, the Republic, Youngstown, and Inland companies, while others included with these the Otis Steel, Midland Steel Products, and even the Bethlehem Steel Company. No evidence is available to show that any such undertaking is actually being pushed. In the tool-steel field, likewise the Ludlum Steel Company has absorbed the Atlas Steel Corporation of Dunkirk, N. Y., with a subsidiary in Canada. This makes it one of the largest units in its field in this country.

Of late considerable attention has been called to the Detroit

district and to the large development which is taking place in that section.

Most of the nine months of 1929 were record-breaking ones in nearly all departments of the steel industry. The production of pig iron during that period totaled 32,649,182 gross tons, or an average per month of 3,627,687 gross tons, which means that were this rate to keep up for the remainder of the year the total would run well over 40,000,000 tons, compared with 37,800,000 in 1928 and 39,100,000 in 1926, a record year. The average production for the first nine months was about 85 per cent of capacity as computed by the American Iron and Steel Institute.

The nine months' production of steel ingots totaled 43,243,404 gross tons, which is also a record tonnage for a like period, and the average per month for the nine months was 4,804,822 gross tons. The production average was about 92 per cent, based on the capacity computed by the American Iron and Steel Institute.

Iron Ore—Coal and Coke

There is little doubt that 1929 will set a new high record for ore shipments from the Lake Superior region. Shipments to October 1 totaled 53,264,927 gross tons, with shipments during the months of June, July, and August being over 10,000,000 tons per month. At this record-breaking rate it is expected that 1929 shipments will exceed 67,000,000 tons as against the record set in 1916, of 66,000,000 tons.

There has been a tremendous development of interest in ores during the past year: more exercising of options on both high- and low-grade ore properties, particularly during the last few months, than there has been in many years. There has been more interest in concentration of ores in the last year than for many years; and there is an increasing appreciation of the vital necessity of ore reserve; and, because of these factors the ore situation is becoming more firm at home and abroad, and beneficiation of the low-grade ores will gradually assume greater importance in production.

In the field of individual developments the following, among others, may be pointed out.

The last year has seen earnest steps taken and numerous plants built to beneficiate our coals. Both wet and dry processes are in operation commercially, but it perhaps is too early to draw definite conclusions as to the best one to use. In fact, there is such a variation in individual coals and the purposes for which they are used that no one process may fit all cases.

When coal has been improved and is of a quality suitable for metallurgical coke, it certainly tends to greater uniformity in the coke.

The coke used for metallurgical purposes has also been greatly improved because of more careful selection of the coals used in making it, and because of proper sizing and screening and the development of a market for the remainder of the product.

Blast Furnaces—Open-Hearth Furnaces

Recent experience seems to have clearly indicated the merits of the wide-hearth blast furnace. One such furnace with a hearth diameter of 24 ft. 6 in. and a bosh of 26 ft. 3 in. is said to have produced in 1928 a daily average output of 1008 tons.

A paper entitled "Recent Developments in Blast-Furnace Construction and Practice" which was presented at the Society's Cleveland meeting by Arthur G. McKee, covers quite thoroughly the more recent advances in iron making. In it the author discusses construction, size, auxiliaries, hot-blast stoves, gas-cleaning equipment, and the use of blast-furnace gas in other departments of a steel plant. He also pays a greatly deserved compliment to the group of enthusiastic engineers in the Bureau of Mines at its Minneapolis headquarters. The investigations already made there have been of great value, and the watchful cooperation of all interested in the manufacture of iron and steel should be unstintedly given.

Blast-furnace gas is now being used satisfactorily at coke ovens, thereby releasing the coke-oven gas for other purposes. Mixtures of these gases have been found to give excellent results in other heating operations, and with reduced costs.

The more economical utilization of blast-furnace gas in conjunction with powdered coal in the generation of high-pressure steam is important.

Recent developments in blast-furnace design have called for corresponding changes in turbo-blowers, charging and filling equipment, control of charging, heat practice, and more effective stove equipment.

Proper sizing and preparation of coke and other raw materials and sintering of ores and flue dust have done much to make a more uniform and increased product, and increasing knowledge of the advantages of sintering has resulted in an extensive program of sintering-plant building, these plants apparently being largely of the Dwight-Lloyd type.

No definite decision has been reached as to the maximum size of open-hearth furnaces. According to King and others, the large furnaces are the most economical, and their control is satisfactory.

Doubtless what might be most economical for low- and medium-carbon steels where large tonnages could regularly be disposed of, might not prove to be so for other steels calling for great variation in analysis and which are of limited application in use.

Size might well be a plant problem.

The extended use of new designs of ingot molds and hot tops is of interest.

The Metallurgical Section of the Pittsburgh Experiment Station of the U. S. Bureau of Mines in cooperation with Carnegie Institute of Technology and the Metallurgical Advisory Board has conducted experiments, the results of which have recently been released, showing that the amount of iron oxide dissolved in liquid steel is very much higher than formerly believed to be the case. This fact, it is stated, "changes the concept of methods of working open-hearth heats to a considerable extent, in that it emphasizes the importance of chemical composition and physical properties of the slag and the necessity for an even more careful study of deoxidizers than has been made up to the present time."

Experiments on electrolytic methods for the extraction of non-metallic inclusions from steel are also under way.

A paper was read before the Iron and Steel Institute by E. J. Janetsky entitled "A Study of Basic Open-Hearth Slags by Solidification Tests." Therefore there are good reasons to hope for real enlightenment on open-hearth practice.

The Bessemer Process

Under the leadership of Dr. G. B. Waterhouse the industry can confidently look forward to practical suggestions for improvements in practice in the bessemer process. Already changes in operation and certain refinements have brought about the replacement of open-hearth with bessemer steel in certain lines.

Rolling Mills

Work has been going on looking to the improvement of the newer methods of rolling wide strips by the continuous process and getting the product of proper quality and under control.

Advances have been made to a marked degree on older mills of the ordinary pattern in output and cost, largely due to continuous heating and rolling changes.

Electrification of old mills and installation of new ones have continued throughout the year. One of the newest is a Morgan mill built for the Sharon Steel Hoop Company, which rolls strip from $2^1/_2$ in. to 10 in. wide at speeds up to 2400 ft. per min. in coils

of from 150 lb. to as high as 2000 lb. All strips are produced from 30-ft. billets. The mill is so arranged that the pulpit operator can receive instructions as to operations and speed changes from a loud speaker mounted on the pulpit, the roller talking into a microphone located on the operating floor.

Pipe

Many improvements have been made in the methods of production and subsequent treatment of seamless tubing, and expanding up to large sizes has been introduced commercially. New methods of welding have come to the front and a huge tonnage of the larger sizes has been manufactured; smaller sizes and light gages are also being produced on a large scale.

Wrought Iron

Wrought iron is being commercially produced at Warren, Ohio, by the Aston process, in which a blown metal is pounded into molten slag of the proper analysis held at the right temperature, the resulting sponge or ball of iron being then squeezed, after the slag has been poured off, and the bloom rolled without reheating into muck bar or billets.

Alloy Steels

Great progress has been made in the development of steels for special purposes, such as those which will resist corrosion and are capable of withstanding high temperatures, and also in the ability to produce a large output at decreased costs.

Furnaces

Marked improvements have been made in heating, etc. Kathner and other normalizing furnaces have been installed and are producing a satisfactory product of sheets. The Kathner furnaces use insulated shafts throughout as the conveying mechanism to avoid loss of heat. They are 155 ft. long, and have a heat zone of 75 ft. and a cooling zone of 80 ft. The heating zone is divided into a preheating section of about 35 ft. and a soaking section of 40 ft. The preheating section has no burners within 15 ft. of the entering door, and receives its heat by the backflow of gases from the rest of the furnace. Automatic control equipment has been a factor of importance in this development.

The size of arc furnaces has been steadily growing, the largest, it is believed, being operated by the Timken Steel and Tube Co. at Canton, Ohio. These furnaces in their rating closely approach to the smaller size of the regular open hearth. Of late the electric furnace has found an important application in the field of recovery of chromium- and nickel-steel scrap. When handled in an ordinary open hearth this scrap loses the valuable alloying elements to the slag. In an electric furnace it can be melted practically without any such loss. The furnace installed for this purpose is said to be an induction furnace with the coils located above the hearth. It is of 6 tons rated capacity, and while its initial cost is rather high owing to the very low frequency that has to be used, the economic results of operation are said to have proved to be highly attractive.

The high-frequency furnace has been making further progress, unusually large units having been installed in several places, among others, at the Heppenstall Forge and Steel Company. An interesting feature of the development of this furnace is the continuous reduction in the frequency employed, which makes for cheaper generators and controlling machinery.

Nitriding

This process was developed in Germany some five years ago. Only during the last year has an apparently successful effort been made to introduce it on a commercial scale in the United States. The largest nitriding furnace in the world is being installed in a plant of a midwestern steel company.

Machines and Tool Materials

Wonderful strides have been made in the last two years in machine-tool design. In fact, so many improvements have been made as to render practically obsolete, for purposes now required in up-to-date shop practice, tools but a few years old.

The newer cutting materials have demanded some of these changes. A whole series of materials of great hardness and resistance to wear has been brought out. Among these are Carboloy, Firthite, or Widia, a tungsten carbide embedded in a matrix, the essential constituent of which is cobalt. Others include such materials as Stoodite (a hard chromium-iron alloy with some manganese), Borium (tungsten carbide base), and Blackor (also a tungsten carbide alloy). All of these are either welded on or mechanically attached to a steel extension piece, while some, including Stellite, may also be applied as a facing on a steel base.

Sponge Iron

Blast furnaces have not as yet been eliminated. Rumors are to the effect that headway is being made with the so-called Hornsey process. The Smith process may prove to have a certain field; some of the results look hopeful.

Centrifugal Casting

Maj.-Gen. C. C. Williams has announced that experimental work on the centrifugal casting of guns leads to the belief that the process has been satisfactorily established for the 37-mm. gun, the 75-mm. infantry mortar, and the 75-mm. howitzer. Also that a larger machine is being constructed for production of the 75-mm. field gun and the 105-mm. howitzer. It is asserted that the physical properties obtained from centrifugal castings, after treatment, are superior to those obtained from forgings of the same composition.

Billet Chipping

An earnest effort is being made to do away with the chipping of billets by compressed-air-operated chisels. In the past year several machines have been placed on the market, one of them a miller, another a planer, while a third, for round billets, operates somewhat like a pencil sharpener. A certain amount of research has been done by several steel companies to determine the extent of surface defects which have to be removed by chipping and whether there is any way of reducing their number or eliminating them completely.

Scrap

A research bureau has been launched by the newly formed Institute of Scrap Iron and Steel, Inc., to make a thorough survey of every phase of direct dealing between consumers and producers of scrap. Owing to the wide distribution and use of alloy steels, the proper classification and economical use of scrap steel is becoming of increasing importance.

Foreign Patents

A significant development in the past year is represented by the tendency of American manufacturers to take out licenses under patents originating in Germany. Two of the most important of such developments have been the introduction of cutting metals of the tungsten carbide type, referred to elsewhere, and the introduction of the nitriding process, both inventions of members of the staff of the Krupp Company. Another foreign invention taken up by an American manufacturer is pearlitic cast iron. The Midvale Company, on the other hand, has taken out licenses under French patents owned by the Commentry-Fourchambault et Decazeville Co. for the manufacture of a heat-resisting alloy of the chrome-nickel-iron type.

C. Snelling Robinson, *Chairman.*

Progress in Machine-Shop Practice

Contributed by the Machine Shop Practice Division

Executive Committee: W. J. Peets, *Chairman,* Carlos de Zafra, *Secretary,* K. H. Condit, W. W. Tangeman, and J. W. Roe

MEASURED by the advances in machine-tool design, the progress in machine-shop practice during 1929 has been considerable. Since the greatest part of any possible advance in this art centers about the availability of improved production equipment, this particular measure is probably as significant as any that could be selected.

The second machine-tool exposition held by the National Machine Tool Builders' Association served to introduce a record number of new pieces of machine-shop equipment. This show took place in Cleveland early in the autumn, and was attended by some 25,000 visitors, almost all of whom were the chief executives, operating heads or specifying officials of machine-tool using organizations. Many men of long experience in the industry expressed the conviction that never before had so many prominent men of the industry gathered in one place. And they were well repaid for coming, because they saw in operation something like 150 new machine tools, as well as many others that had been on the market for some little time, but were still sufficiently recent in design to be far in advance of much of the equipment that is now in use.

The following statement, taken from the Show Number of *American Machinist,* outlines the more important developments:

"The substitution of automatic for hand operation on a number of the machines developed is a prominent feature in the equipment placed on exhibition. Wherever feasible this improvement has been made. Such developments have demanded no little skill and ingenuity on the part of the machine designer and builder. Radical changes were required in most cases. The resulting equipment requires more care in set-up, more certain means of lubrication, and may involve a higher maintenance charge on account of the refinement of parts introduced. On the other hand, sturdiness has been added in most cases in developing or redesigning such types of equipment. Adjustments in its use, of course, must be made by skilled mechanics who are experienced in special machines, rather than by the ordinary machine operator. But to offset any increased initial cost, and any added operating or maintenance expense, a vast increase in output has been brought about, making the unit cost of products manufactured only a fraction of what it was when former types of equipment were employed.

"Mechanical features of operation are well typified by a feeding device developed and applied to one of the well-known lines of automatics. No operator is now required for this machine. A long runway holds a store of the work, and the two-arm work-feeding mechanism picks up one part at a time and brings it into position between two tool-holding slides, one of which carries turning tools, and the other grooving, facing, and forming tools, where it is held between centers. The work is driven by the mechanism. When the machining has been completed a second arm automatically moves up and discharges the piece on a runway carrying it away from the machine, while the first arm moves in a new part for machining. The machine continues to operate in this way until stopped by the push-button control.

"The present tendency in machine design is rather away from the single-purpose machine. For high production and very special work the single-purpose tool, of course, will always find a market. But its limitations when sudden and radical changes in the design of products come about are causing machine-too builders to devote much less attention to this type of equipment, and more attention to the provision of special fixtures adapting standard tools to definite production jobs, and to the design of unit-type equipment to be built up into various combinations suited to the requirements of different jobs. This tendency is most decided and undoubtedly will continue to be a major factor in machine design for a long time to come.

"Even in cases where machines have been developed for special purposes there have been introduced certain features which widen the uses of the equipment. For instance, a certain type of grinder designed for special railroad equipment work on a production basis has been adapted so that the machine can be used for tool grinding or production grinding on other types of work.

"There is a definite tendency toward a more extensive use of hydraulic mechanisms on numerous types of machine tools. At the show, new applications of hydraulic feed to equipment such as lathes, grinders, smaller sizes of milling machines, multiple-spindle drills, honing machines, and broaching machines were demonstrated. Further improvements in indexing have been made on machine tools placed on exhibition this year. One outstanding development is the application of the double Geneva motion on a work-rotating chucking machine with an unusually large turret that is indexed in four positions 90 deg. apart. This machine also represents several other outstanding developments in machine design.

"Increasing attention to lubrication is decidedly evidenced by the equipment developed during the past year. No definite tendency toward any one type of lubrication is to be discovered. Some manufacturers have adopted central, forced-feed systems for their equipment. Others prefer gravity feed from central reservoirs. Still others retain the oil cups for individual bearings. Combinations of systems are also of frequent occurrence. For instance, the chucking machine mentioned employs a central lubricating system for the main bearings of the machine, but a gravity-feed reservoir for the heavy turret, to avoid the use of slip joints which would be required if the main system were utilized for turret lubrication. One manufacturer is introducing a forced-feed lubricating system operated periodically under the control of an electric timing clock. Oil filters are also finding more extensive application. In no case is lubrication neglected as a factor in machine operation and maintenance.

"Many other factors have become of increasing importance in machine design during the past year, and characterize practically all of the equipment placed on exhibition at the show. Among those factors which have received special consideration are: A higher degree of accuracy in the parts comprising machine tools and equipment, provisions for a higher degree of accuracy in the products turned out, ease and convenience of operation, reliability of service, compactness of design, decrease of floor space occupied, simplicity of drive, reduction of power consumption through the liberal use of ball and roller bearings, higher grades of steel and alloys for journals, spindles, gears, and other operating parts of machines, convenience of inspection and cleaning, provisions for the removal of chips, facilities for mechanical handling, and the features of higher production, greater automaticity, and adequate lubrication, which have been discussed."

Further evidence of the ability of machine-tool builders to co-operate was given by the adoption of a standard color for machine tools. With very few exceptions all machines exhibited at Cleveland were finished in this color, and the pleasing appearance of uniformity was sufficient justification for the move. Most of the builders who have adopted the standard color are making a small extra charge for finishing their products in a special color specified by the customer.

Because of the high rate at which machine-tool plants have been operating for the past year, the designing and building of the new models exhibited was attended by considerable difficulty. In fact, some of the innovations intended for Cleveland were not finished in time and will be announced later. This situation augurs well for the future. Not only are there more new machines on the way, but because of the record-breaking activity of the builders, profits have been more nearly commensurate with the efforts of the engineers and construction forces, and consequently there will be more money in the future for the research work that must be done if the art is to continue to advance.

The facilities of the machine-tool building plants have also been increased during the year. Several new engineering buildings have been erected, and plant additions have been made to take care of greatly increased orders. Overtime and double shifts have been common throughout the industry.

Undoubtedly the most important single development of the year has been the progress made in adapting the new tungsten carbide cutting tools to machine-tool uses. It must be admitted that many disappointments have accompanied the efforts to apply tungsten carbide, but these were to be expected, and on the whole there has been appreciable progress.

Unqualified success has attended the application of this material to the machining of rubber, fiber, and similar materials; and to the machining of brass, bronze, aluminum, and the like; also in most cases where cast iron has been the material to be cut. But like success cannot be reported in cutting alloy steels. Here the fragility of tungsten carbide incident to its extreme hardness has led to failure where there was the least chance of chatter. Much of the difficulty is now attributed to the means of holding the cutting bit to the shank of the tool. Brazing, atomic-hydrogen welding, and more recently mechanical means such as dovetailing have been used for this purpose, but with results that indicate the necessity of further research.

It must be admitted that there has been considerable disappointment at the failure of this new cutting material to solve all the difficult machining problems of the shop, but it should be observed that much of this disappointment is entirely unjustified, and should not lead potential users to distrust its future possibilities. Too much was expected of a substance about which there was insufficient knowledge. When that knowledge has been obtained there is every reason to believe that tungsten carbide will do all that has been claimed for it.

A year ago there was a general belief that tungsten carbide would bring about an immediate revolution in machine-tool design. This belief has not been realized. A few machines have been speeded up to meet the requirements of the new material, but at least some of the more recent designs have been found quite adequate to develop the full possibilities of it. Evidently the change in design is to be an evolution rather than a revolution.

An interesting effect of the introduction of tungsten carbide has been the improvement in high-speed steels. The threat of competition has driven the producers to extra efforts, and the result has been that some of the current products show cutting ability as much as 25 per cent ahead of anything that has been available hitherto. Further advances are probable, especially because experience with tungsten carbide will accustom the user to the brittleness of a diamond-hard alloy, and will thus lead him to accept some lessening of the toughness of high-speed steel if it can be made harder. When the user accepts this situation the maker of high-speed steel can develop steels with entirely new characteristics.

While the new cutting materials have occupied the center of the stage, developments of other new materials used in the machine shop have proceeded apace. Among the important ones is high-test cast iron, practically a new material. Cast iron of as high as 85,000 lb. per sq. in. tensile strength has been produced, and one foundry is consistently attaining strengths of 65,000 lb. Four processes are in use, all depending on the holding of the liquid iron at a high temperature, in the neighborhood of 3000 deg. fahr., until the carbon has been dissolved, thus preventing the formation of the plates that weaken the structure of ordinary iron.

The research organizations of the aluminum, brass, and nickel companies have perfected many new alloys and improved older ones. Plastics have come very much into favor, and are replacing metals in some instances. "Stainless" steels have attracted considerable attention, and nitrided steels have found new uses.

All of these advances point to the need for more and better organized research work in the machine-shop-practice field. A little is being done by a few of the larger units, but in the aggregate not much has been accomplished. From the very nature of machine-shop work, and the absence of any shops of dominating size, the problem of how to organize research of the kind needed is difficult. Probably the only solution is a central institute or laboratory to be supported by contributions from the various trade associations and individuals in the industry, but before such an institution can be established there must be an awakening to the true significance of fundamental and applied research. Much educational work lies ahead of any group undertaking to solve this particular problem, but the necessity is so great that it will justify large effort.

Standardization work in the machine-shop-practice field is in somewhat better shape than is research. Only one standard has been approved by the American Standards Association during 1929, that for tool-holder shanks and tool-post openings, but the following are in type and are practically completed by the sectional committees: Spur-gear tooth form, full depth system; inspection of gears; gear materials and blanks; taps, cut and ground threads; milling cutters; radial ball bearings; slotted-head screws; line work on drawings; and motor-frame dimensions.

During 1929 some progress has been made in improving management methods, and particularly cost methods. The outstanding example is the work of the National Machine Tool Builders' Association under the direction of its general manager and his staff cost consultant. Much progress has been made in getting uniformity of cost methods so that true comparisons are really possible. By this means the plant management can tell with some assurance whether it is efficient as compared with its competitors. Other branches of the field would do well to take steps toward the same goal.

Management throughout the industry has evidently accepted the soundness of the modernization principle. The greater part of the record business of 1929 has come from replacements of obsolete equipment rather than from plant enlargements. A certain amount of replacement business has had to be postponed by equipment builders because of their inability to make deliveries. The recession in the automobile industry, and the general slowing down that seems likely until the confidence shaken by the recent stock-market gyrations has been restored, will give an opportunity for the builders to catch up on their orders, and put their full effort into campaigns to replace the vast quantity of obsolete equipment still in use.

K. H. CONDIT.

Progress in Industrial Management

Contributed by the Management Division

Executive Committee: W. L. Conrad, *Chairman*, Robt. E. Newcomb, *Vice-Chairman*, G. W. Kelsey, *Secretary*, C. E. Hagemann, Wm. B. Ferguson, and Chas. W. Lytle

WITH the nation-wide interest shown by business men in the problems of "waste in industry" has come a steadily increasing effort toward the elimination of this waste and the introduction of methods of managerial control in industry. As the manufacturers, distributors, and consumers have studied existing waste of time, material, and human energy in our productive and distributive processes, their sense of responsibility for the waste, its causes, and its correction has resulted in a determined effort for its elimination. Not only have these industrial interests asked and received cooperation from one another, but they have also appealed to the Department of Commerce, Chamber of Commerce of the United States, and professional societies for cooperation.

This cooperative effort has helped to reduce inventories and idle investment, to increase the turnover of inventories, to increase sales volume, to reduce manufacturing and selling costs, to increase profits and values, and to improve quality and service. The success of the simplification movement has stimulated interest in standardization of grade and quality of products; and has advanced materially the development of specifications, particularly the more general use of specifications in buying.

The elimination of waste in industry is taking a new turn. It is now realized that, besides the waste of concrete materials resulting from overdiversification and other causes, there is a tremendous waste through the use of inefficient processes for the production, transmission, and utilization of energy.

The history of the recommendations made by the many agencies that have studied the problem of managerial control, shows many good examples of that flexibility which enables the simplified-practice recommendation of any industry to keep pace with changing consumer demand. Adding items as new developments require and discarding the obsolete have a stabilizing influence to retard any rapid increase of unnecessary diversification such as frequently takes place in an industry that has no definite program of simplification. Manufacturers have justly benefited through fewer interruptions for adjusting machinery, the release of unproductive space for other purposes, etc.

The interest that has been manifest in managerial control in industry during the past few years, and especially the searching investigation that the financial institutions now make into an industry before they agree to any proposed expansion of that industry, or to the expenditure of any considerable amount of capital, shows conclusively that more attention is being given to managerial control than was formerly the case. Continuation of this practice augurs well for the future of all industries.

Another tendency which is becoming manifest is the realization that conservation and efficient utilization of resources apply to man-made as well as to natural resources. So much capital is now tied up in our great industries, and so many people are dependent upon them, that it is no longer possible to scrap an entire industry because science has developed a new product to replace the one which that industry turns out. The complete abandonment of certain facilities in favor of others without careful study will not occur so often in the future as it has in the past. The almost complete overthrow of our highway and waterway systems by the railroads, in the end proved an economic blunder. We know now that research could have coordinated them with tremendous savings. The railroads have learned a lesson, and the result is the present effort to coordinate rail, highway, and aerial transportation facilities, with the hope of producing a unified and efficient system.

Managerial Control in Industry

With the demand for economy increasing until it has become a most important factor in the onrush of industry, little is wasted nowadays. Profitable business enterprises are built upon by-products and materials that once were thrown into the discard. No longer are sawdust, waste oils, scrap iron, and miscellaneous factory débris cast aside to be forgotten.

The report of the Committee on Recent Economic Changes says in reference to managerial control in industry:

> The chapter of this report on industrial management prepared for the committee, presents the results of analysis of 100 fair samples of normally successful established business institutions, so chosen as to show prevailing practices. This chapter shows that more men are being brought within managerial responsibilities and that the "big boss" is passing. There is today not only more production per man, more wages per man, and more horsepower per man, but more management per man as well.

The increasing introduction of scientific management methods in America, the intensive competition, and the increasing importance of the control of details for desired profit is making the importance of detailed managerial control through thermometrical budget and cost information more and more important. Budgets and the actual performance in conformity show the greatest progress.

The improved and wider usage of budget systems is a definite step of management progress, and is bringing about greater detailed and intelligent coordination between production and distribution.

The effort toward waste elimination in America is probably doing more to advance managerial control and increase profits than any other single element, since it compels detailed study of operation.

Better Management

"There are greater profits through better management, as revealed through simplification, the elimination of waste, more highly efficient personnel, and a finer spirit of cooperation," said Craig B. Hazelwood, vice-president of the Union Trust Company of Chicago, in a recent article. In this article Mr. Hazelwood stated that "the amazing spectacle of the youngest of nations in the vanguard of commercial progress pays silent tribute to the creative genius which has so distinguished American business." Continuing, he said;

> In the face of this remarkable development it is natural, but unfortunate, that the emphasis be placed upon size and volume, attributes which can never measure up as the ultimate aim of industry. In the fast-running current of these days, we need to take a new grip upon the practical realities of business, realizing that though we set up the greatest retail business, the largest factor, the biggest jobbing organization in the country and have not profits we have failed to be of permanent service to the public. Fortunately, we are now in the

morning hours of a new era in scientific management, revealed through simplification, the elimination of waste, more highly efficient personnel, and a finer spirit of cooperation.

ETHICAL STANDARDS

The most outstanding contribution of the year in the field of industrial literature is the two-volume report entitled "Recent Economic Changes," issued by the National Bureau of Economic Research. This is an outcome of the President's Conference on Unemployment and is a most searching study. Every conceivable phase of industry is covered and the very best information is made available regarding all of the important trends. Much stress is placed on the social efforts of our greater productivity. Greater earnings and shorter hours together have increased the demand for goods, and this demand is by no means restricted to necessities. To quote briefly: "The survey has proved conclusively what has long been held theoretically to be true, that wants are almost insatiable—that one want satisfied makes way for another. The conclusion is that economically we have a boundless field before us, that there are new wants which will make way endlessly for newer wants as fast as they are satisfied."

The connection between scientific research and industrial management is more direct than might at first be imagined. The development of new and improved materials and of better and more economical processes has a profound influence on management methods.

The past year has shown an increasing realization of the fact that management can be truly efficient only if the thing managed is efficient in itself. The efficient management of a horse-drawn dray will not result in lowering the cost of transportation to that by motor truck. Industrial managers are looking more and more deeply into the equipment and processes employed in their plants to make sure that they are the best for each particular purpose. Often the manager is able to see chances for improvement which might be overlooked by those more directly concerned with the actual mechanics of the business.

WAGE INCENTIVES

For some time a tendency has been developing to make more and more group applications of incentive plans. This is a natural accompanyment of mass production in that more and more work is interdependent. As in all new things, there is, however, a danger of this change swinging too far. Since task standards need only be set for the whole assembly and the subordinate parts merely balanced, it is an easy way to avoid some of the preliminary job standardization and much of the paper work in operating. If equal results were possible there could be no objection, but it is well established that group effort is neither that of the least efficient or that of the most efficient, but a mean between. In fact, the effort may be even below the mean if leadership is not properly exerted, and leadership cannot be properly exerted when groups are large. It is in this respect that group applications have been carried beyond their suitability. Such companies as the Western Electric have gone through this stage and are now deliberately returning to individual applications, except where jobs are definitely interrelated and where leadership can be effective. Plans which use the man-minute for production control have spread rapidly during the year and are undoubtedly achieving a greater unity of control than anything ever achieved with the man-hour, although the reason for this is not fundamental. It simply happens that such plans as those of Bedaux, Haynes, Parkhurst, and Dyer have worked out comprehensive systems for unified control and are not installed without control. Office work and all indirect work in the factory are just beginning to have extra-financial incentives. This is merely because such incentives have to follow job standardization, and employers are now learning to apply such standardization to the more difficult types of tasks.

At the same time, incentives are being extended to supervisors and executives, some on a profit-sharing basis, but many on a real accomplishment basis. The former is effective for the highest executives, but much less so for those below the general manager, because the relation between the reward and the effort is always remote under the profit-sharing type of plan and may even be quite unrelated. Furthermore, incentive plans are being scrutinized on their real merits and are not being accepted so readily because of high-pressure sales on the part of consultants. (C. W. Lytle, "Wage Incentive Methods.") It is not unusual in well-managed companies to have as many as 80 or even 90 per cent of the employees on an incentive basis today. Some companies are even applying incentives to the elimination of accidents. It has come to be the accepted thought that safety is primarily a management responsibility, but the fact that our industrial accidents last year amounted to $1,000,000,000 indicates the need for still better attention to this problem.

OBSOLETE EQUIPMENT AND ITS RELATION TO PROFITS

Probably the most important questions that confront the manufacturer today are the relation between the condition of productive equipment and profits, and the replacement of machinery which in point of service may have many years of usefulness, but which is incapable of satisfying the latest fancies of the consumer market or competing with more recent and improved machinery. This has been a difficult point for manufacturers, and has prompted a request for a study of this problem.

The important phases of the industrial-equipment studies are, (1) to bring out facts showing the relation of equipment obsolescence to production costs, and (2) to discover, if possible, a means for correctly evaluating and providing for obsolescence in cost accounting. The first result is expected to be obtained by the study of machinery among manufacturers of the several classes of machinery. The second result is expected from an investigation among the users of such machinery.

The practical value of such studies will be, it is hoped, the establishment of a truer accounting for obsolescence as a hazard rather than an arbitrary compromise as at present. Wear and tear, or depreciation, is a scientific problem, and can be determined with considerable accuracy. Obsolescence is more nearly analogous to fire. As a risk it cannot be predetermined any more than can the date a building will burn. An arbitrary basis of accounting for the two factors does justice to neither, and fails adequately to provide for a fund for replacing the machinery when its value has been destroyed by the factor of obsolescence.

Keen competition, as well as reasons other than inefficient machinery, has caused some of our plants to liquidate.

Plants that have had the money to invest have discarded old equipment as far as possible, but those industries which have been running and which have antiquated machinery have been dragging along at a loss or no profit, or have liquidated.

The chapter on Industry in the report of the Committee on Recent Economic Changes, gives striking evidence of the differences in utilization of productive factors by the prosperous as compared with more backward manufacturing industries. The yardstick adopted is productivity per man-hour. In general, where productivity has increased, industry has been prosperous; where it has increased but slightly or has decreased, the industry is in difficulty.

Utilization of power, of buildings, and of equipment are important factors. The increase in the manufacturing of machinery, for example, probably approximates or perhaps reaches higher levels than the increase in industrial power.

Experience is showing that in these competitive days the mathematical relation between obsolete machinery and profits is an inverse ratio.

A few months ago, Ray M. Hudson, Assistant Director, Commerical Standards, said that:

As competition increases, price cutting occurs, until the craze for volume swells sales expenses, increases distribution costs, and reduces profits, even though the factory be operating at capacity. In cases where factory capacity is in excess of current sales volume, pressure for greater volume becomes acute, and greater effort is made to secure it. New ideas in selling develop.

Among recent proposals is "progressive obsolescence," meaning the quickening of sales by inducing people who can afford to buy a greater variety of goods on the same principle such people now buy autos, radios, and clothes, i.e., "not to wear out but to trade in or discard after a short time, when new and more attractive goods or models come out." While some stimulation of obsolescence is not uneconomic, the danger lies in its probably application to buyers who cannot afford it, and who might better put more of their income into more permanent investments. That uncontrolled obsolescence has great potentialities for economic waste and loss is obvious. Too high a frequency of purchase is relatively as wasteful for the consumer as too high a frequency in change of design, size, style, or model is for the manufacturer and the merchant.

Standardization as a Factor of Management

Mass production is dependent upon the adoption of dimensional standards. Standards of this kind—in fact, most of the standards in existence today, as distinguished from "quality specifications"—have been developed by producer organizations operating either as individual firms or as groups of firms brought together through some such agency as a trade association.

With few exceptions, industrial executives are in favor of such dimensional standards as will permit mass production, and of quality specifications for the materials purchased by them. The more progressive of the executives are in favor of service or performance specifications for goods sold by them and their competitors, although not a few of them are opposed to "composition specifications," which are looked upon by them as tending to retard improvements.

To the extent that standardization does in fact retard improvement it is disadvantageous; to the extent that it eliminates the less desirable in favor of the better commodity it is advantageous. At an ever-increasing rate industrial executives are realizing that when properly carried out standardization simultaneously eliminates the unworthy and identifies and sets forth the best, not as a finality, but as a starting point for improvement.

Reasonable specifications, formulated after thorough interchange of ideas and experiences of the manufacturer and the user, and setting forth those requirements considered essential to safeguard the consumer without hardship to the manufacturer, serve to show to both parties to the contract what service the commodity must render, and how it must be manufactured in order to fit it for use. It is to the best interest of all persons concerned that the specifications be formulated jointly by both parties to the contract, working together harmoniously, each benefiting from the knowledge and experience of the other.

Management may be defined as the judicious use of means to accomplish an end. Business management naturally consists of the careful guidance of men and material in the production and sale of a commodity that will produce the desired end—namely, dividends.

The industrial community is receiving valuable assistance in establishing means for accomplishing these results from the Bureau of Standards.

Management is vitally affected by nationally recognized grades, by standards of quality. To fully analyze this question it is always well to consider it from the standpoint of the interests of the various branches of industry.

One of the commercial standard publications quotes R. P. Lamont, Secretary of Commerce, as saying that:

Standards constitute the common language, even the common law, of modern industry and commerce. Certain standards, such as those used for weights and measures, are essential for public convenience, health, of safety, and have been fixed by legislative enactment. Mandatory standards of this character, however, are few in number when compared with the large and steadily growing volume of standards developed by industry and commerce and voluntarily maintained.

Recognized standards of this character developed by cooperative effort on the part of designers, manufacturers, distributors, and users constitute a powerful force for eliminating waste in production and distribution. Simplified practice, meaning elimination of unnecessary variety of products, and concentration on a small number of standard products, offers many striking examples of the enormous benefits to be gained through voluntary cooperation. Many different groups must cooperate not only in developing standards but in establishing and maintaining them in general use.

Such voluntary cooperation is of equal value in providing means whereby standards may be modified to meet changed conditions or new development.

Continued calls for cooperation in the endeavor to establish standardization as a factor in management have caused agencies of the Government to augment its service to industry, and its Division of Trade Standards is working with nearly fifty different commodity groups in perfecting standards of grade and quality for their products.

The enlarged export business of the United States and the rapidly growing use abroad of simplification and standardization has brought a demand for further cooperation in the translation of American standards and specifications into foreign languages for the convenience of foreign consumers. Service of supply, including transportation facilities and means of communication, has advanced to the point where buyers no longer shop exclusively in the nearest market.

Russell Forbes, the nationally known expert in purchase practice, in his book entitled "Government Purchasing," says, according to the A. S. A. Bulletin, that: "The treatment of the purchasing problem will be of direct interest not only to federal, state, county, and municipal buyers, but also to every one concerned with the allotment and expenditure of tax moneys, and to purchasing agents of large industrial concerns." He recognizes with unusual clarity the importance of standards as a factor in the purchase problem, and cites important instances of savings gained through the standardization technique.

One factor which has contributed largely to the notable increase in manufacturing efficiency in the last two decades has been the development of standards in cost accounting. The old system of trial and error has been replaced by accurate facts, and many wasteful production practices have been thus discovered and eliminated. The key to the practical use of cost accounting in manufacturing has been the study of the cost of producing individual items and of performing individual operations.

Standardization has unquestionably been a definite factor in inventory and cost reduction. Its application, however, in a wide manner seems to be more confined to staple articles not involving style or temperamental selection. Its future application might possibly, with beneficial results, be directed to standardization of an article of one concern, rather than of the same article as produced by many.

The great competition today is between industries, and it is natural, therefore, if members of a given industry desire to maintain the standing of the industry as a whole and a recognized standard for their product, they should set up a minimum level for their commodity below which quality shall not be allowed to fall, in order that the public may buy with assurance and confidence, and that the commodity as a whole shall retain the good-will and command the respect of the purchaser.

Coordination of Production and Distribution Methods

The answer to coordination in production and distribution methods is not price cutting, but reduction of waste in physical distribution, says *Distribution Economy*. In this connection, the magazine asks, "When your goods leave the production line, are they handled with the same mechanical skill that produced them?"

Efficiency and scientific management are essential factors in the successful operation of the modern industrial plant. Great progress has been made in these directions by American manufacturers during the last decade. Waste has been eliminated in a thousand different ways through improved business practice, and through simplification of processes and methods of manufacture.

Dunn's International Review, in discussing this subject editorially, says:

> With this lowering of production costs, it is now recognized that the next great field for the reduction of industrial waste is in methods of distribution. Today, the necessity for satisfactory and economical distribution as a means of passing production economies on to consumers is reinforced by the realization that, in many instances, effective distribution is the deciding factor in the new group competition between industries, commodities, and distributors. The idea of a smoother and more economical passage of merchandise from producers to consumers is growing rapidly, and it is to be hoped that the problem will permit of an early solution.

Relatively little progress has yet been made in analyzing distribution costs from the standpoint of the cost of handling individual items or performing individual services. There has been some progress made, and several agencies are attempting some work in this field. Investigations in wholesale and retail distribution for several lines of trade, with particular reference to the small as well as the larger producer and also to the several methods of distribution, show the possibilities for reducing costs through more uniform methods. The purpose of these reports is not so much to provide comparative data on operation costs or to specify wasteful practices, but rather to present a method for functional-costs allocation which may easily be adopted by any industry or branch of industry in determining the profitableness of their own individual commodities, customers, or service.

There have been several attempts in some particular lines of industry at consolidation of plants producing similar goods to bring about the coordination of production and distribution methods. Some of these mergers have been accomplished and should result in diminishing the competition in the distribution of the product.

Various chapters of the report of the Committee on Recent Economic Changes stress the striking progress in coordination of production and distribution. Progress in the later years of the decade has been particularly striking. A recent report, signed by sixteen of the most important figures in industry in the country, including President Hoover, makes this striking statement:

"In the marked balance of consumption and production, for example, the control of the economic organism is increasingly evident," and the Committee insists that "it would seem that we could go on with increased activity, but only if we develop a technique of balance."

Waste Elimination and Its Effect on Industry From a Managerial Standpoint

During the past year considerable progress has been made in reducing factory waste. Early in the year a committee was organized to encourage as an annual national program the holding of campaigns within industry to eliminate waste. During April a large number of companies held an exhibit of waste campaigns which consisted of exhibit boards of factory waste gotten by employees, as well as meetings to stimulate interest in the boards and in contributing suggestions as to how waste might be reduced. Prizes were given for the best board and for every worth-while suggestion.

The history of this movement dates back to the yearly Management Week, which, after being held several years, was discontinued last year as it was felt that the work of attracting attention to better management methods and the responsibility of management could more effectively be carried by individual organizations. On the disbanding of the Management Week Organization, attention was called to the fact that in 1926 the topic of Waste Prevention had been sponsored by the Week and that as a part of it an exhibit campaign had been arranged by Westinghouse Electric and Manufacturing Company at East Pittsburgh. This campaign has had such successful results that the Newport News Shipbuilding and Drydock Company, and later the subsidiaries of the U. S. Steel Corporation and many other plants, organized campaigns. The amazing savings and other benefits secured from the campaigns brought the demand for coordination and stimulation of the work, as a result of which the committee mentioned above was organized.

As part of the movement in 1929, besides the number of companies that put on campaigns there were elimination-of-waste meetings held in over twenty-five cities. Hundreds of booklets describing campaigns already held and how to organize them were distributed during the year to company executives, and it is planned to continue the work annually every April. The most spectacular and successful campaign was organized by the Oakland Motor Company at Pontiac, Mich. Their campaign, called a "War on Waste," opened with a sham battle by the state guards against a waste stronghold, and was followed by an extensive two-weeks' campaign. Eleven hundred employees contributed over twenty-five hundred suggestions on reduction of waste, of which a third were classed as valuable, and it was estimated by the company that half a million dollars would be the immediate saving of the campaign, with a like amount to be secured later.

The tendency to more serious thinking on the subject of waste elimination is developing a better basis for real action along this line in industry. Salvaging is only a minor part of real waste elimination. We need to give more thought to "*not wasting*," as Mr. Ford says, than to reclaiming what is waste.

In the attainment of the elimination of waste, whether of time, material, or human energy, this fact is basic and fundamental. It affords a common cause in which all interests or elements find many opportunities for growth and for the creation of greater wealth, not alone for the few but for the many—in fact, for the Nation.

Waste elimination, by the reclamation and reuse of materials, and the development of commercially valuable by-products, has also been very striking. In the case of reclaimed rubber alone, the figures run to more than twenty millions in a single year.

Waste-elimination programs offer every one in industry an opportunity to cooperate, and are now recognized the world over as a fundamental factor of force operating to help stabilize business, to lower costs of production and distribution, and thus lower the cost of living. Beyond that it works to advance still further our standard of living to conserve our material and human resources.

Greater possibilities for coordination with other activities also obtain. In this connection, attention is again called to the tremendous wastes in distribution, estimated at eight billion dollars annually. At least three billion of this is attributable to waste in physical handling and transportation. A major portion of the other waste also occurs through lack of simplication of method and practice.

W. L. Conrad, *Chairman.*

Progress in Materials Handling

Contributed by the Materials Handling Division

Executive Committee: G. E. Hagemann, *Chairman,* M. W. Potts, *Secretary,* R. H. McLain, F. D. Campbell, C. D. Bray, and E. D. Smith

IT IS IMPOSSIBLE to measure accurately the progress that has been made in materials handling during the past year. First, it is impossible to accumulate proper and sufficient data. Second, there is no real yardstick by which this progress can be measured. A questionnaire was broadly circulated in an effort to secure such information as would be helpful in bringing before this Division the nature and extent of the year's progress in materials handling. The replies received indicate that while there is a great deal of interest in the subject, there are yet many cases in industry where there seems to be little, if any, attention paid to it. The manufacturers of materials-handling equipment seem to be making real progress, and in several cases are doing special research work.

While most manufacturers of materials-handling equipment are conducting their own experiments, much is also being done with the cooperation and assistance of industry. For example, a certain industry will present a problem to a manufacturing company and will agree to work out as far as possible the materials-handling problem. In some cases this may present many mechanical and structural difficulties. The job is then built with the understanding that it will take some time to get the various problems solved. This has been particularly true with the automobile industry. Research work is being done to some extent, in colleges and in testing laboratories, along the lines of heat-resisting alloys for materials-handling apparatus passing through ovens at high temperatures, heat-resisting bearings, and the effect of combinations of water and heat. Lubrication problems, which are very important factors, are being given a great deal of attention and study by both the conveyor manufacturers and the lubricating companies.

Manufacturers of materials-handling equipment report increasing interest on the part of industry, stating that they are now frequently called into consultation when plans for changes or additions are in very early stages so that the scheme or plan under consideration may be developed with particular reference to proper materials handling. They report also that the increased output per unit of machinery has been a big factor in making proper handling methods a necessity. Another very important development seems to be the fact that the average manufacturer now has generally gotten away from the thought that his product could not be handled on chains or conveyers because it was "entirely different."

Clay Products

The tremendous increase in the cost of common labor compelled the manufacturers of clay products to seek mechanical replacement of common labor if the cost of their products was not to become prohibitive. While there has been no organized research work on the subject-matter, the clay-products manufacturers, their engineers, superintendents, and foreman have all engaged in the study of mechanical handling in an effort to reduce labor costs. Manufacturers of clayworking machinery and mechanical-handling engineers, of course, have aided in solving the various problems. Steam, gas, or electric locomotives and cars have replaced the mule carts that brought clay from its source to the plants, conveyers have replaced wheelbarrows in the plants and shipping yards, and tractors convey the finished product, deliver coal to the kilns, and remove ashes and waste material.

With every manufacturer and his working forces assisted by competent mechanical engineers engaged in research study, the clay-products industry has progressed more in the matter of materials handling during the present century than during several hundred years previously, and is now entitled to a very favorable rating as a mechanically equipped industry. These companies report also that savings in labor costs have been large and that the research work is continuing.

Railroads

Several of the roads surveyed have made elaborate studies of the problem of handling and transporting parts and material. Electric hoists on individual cranes and additional installations of traveling cranes have served to reduce handling of parts in process of manufacture or repair in the main shops. Motorized delivery systems have been installed to place material at the point of use and have served to eliminate the expensive and time-consuming method of handling parts by manual labor. In many shops electric platform trucks are now used to handle parts and materials that are loaded on skids.

Undoubtedly the development of the "spot" system of car and locomotive repairs has been the most important influence toward the increased utilization of materials-handling equipment. With this system, both locomotives and cars are moved through the shop from station to station. Only certain kinds of work are performed at a single station. The various parts are routed from the first station to the various repair departments, where they are overhauled and then moved to the proper station on the erecting floor. Lift platform trucks with skids have been found to be advantageous in connection with the spot system of locomotive repairs. In the case of car repairs under the spot system, crane trucks have been found very useful. In fact, several of the Class 1 railroads prefer crane trucks for car-repair work to overhead traveling or gantry cranes.

An interesting development in both car and locomotive repairs, especially coach repairs, has been the increased utilization of the overhead monorail. The railroads, being a transportation industry, are not organized to any important extent to carry on research and development work, and as a result have to depend almost entirely on the developments of materials-handling equipment made by the manufacturer. Railroad mechanical-department officers indicate, however, that they recognize the possibilities of substantial economy through the use of modern materials-handling methods.

Packing Industry

There were a number of developments in packing-house processing during the past year. Gasoline tractors have been designed which have the approval of the insurance companies for use under packing-house conditions. Formerly electric tractors were used, necessitating large rooms for recharging the batteries. The gasoline tractors have eliminated the need of these rooms. A scale used quite extensively in the weighing of coal from coal mines has been adapted to packing-house requirements, auto-

matically records the weights of products upon a tape, and does away with a scaler. A truck has been perfected that will handle conveniently a very much larger quantity of packing-house produce from departments or assembly rooms directly to the cars. This truck has supplanted a number of laborers and has speeded up the operation of loading. A saw has been perfected which will split the entire backbone of a beef carcass. This saw does the work very much more rapidly than was possible under the old method of hand splitting. Furthermore, skilled workmen are difficult to obtain for this operation. Insulated and refrigerated

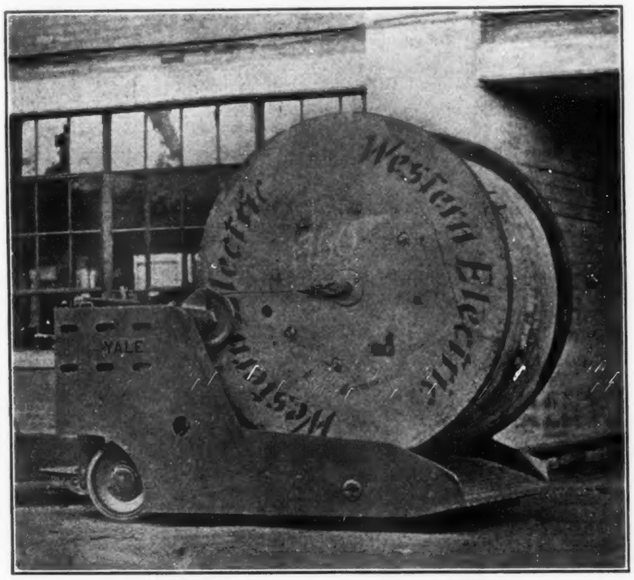


FIG. 1 NEW REEL-CARRYING TRUCK OF 10,000 LB. CAPACITY

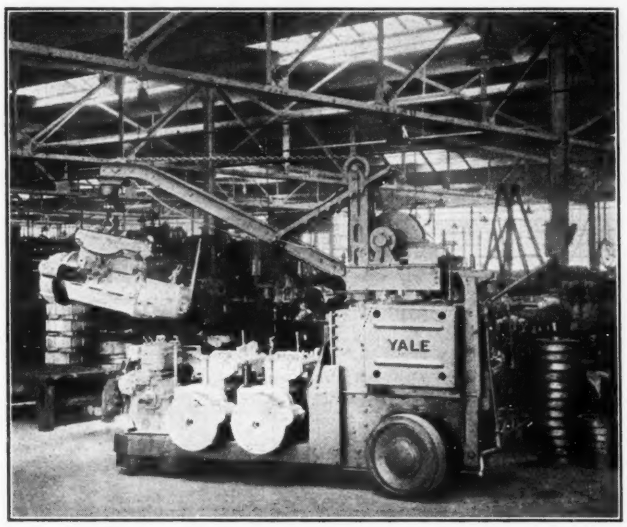


FIG. 2 6000-LB. LOW-PLATFORM, LOW-LIFT ELECTRIC INDUSTRIAL TRUCK WITH 1500-LB.-CAPACITY CRANE

meat trucks for delivery of meat products direct from packing houses to retail stores are finding increased use. These trucks are making deliveries to points at least 200 miles distant from the packing houses. Their use has eliminated several handlings of packing-house products required under the old system of delivery either by express or by peddler cars. Increasing interest is being manifested in railway refrigerator cars refrigerated by the silica gel system. If adopted, this method would eliminate the present need of icing stations along the route of shipment.

INDUSTRIAL TRUCKS

Fig. 1 shows a new 10,000-lb.-capacity reel-carrying truck. It is of the six-wheel type, having, in addition to the regular drive motor, a separate motor-driven unit which operates two

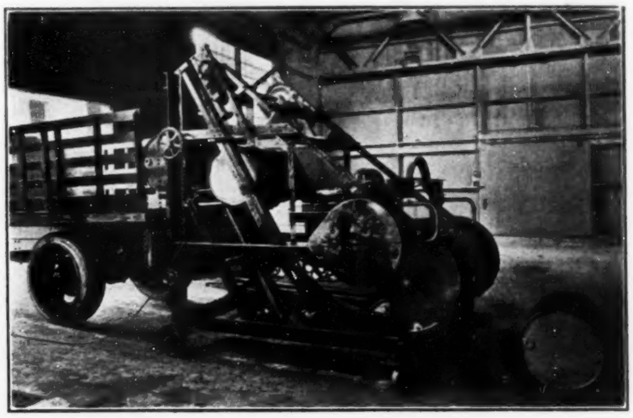


FIG. 3 PORTABLE BARREL AND DRUM LOADER FOR ELEVATING FILLED DRUMS FROM SHIPPING FLOOR TO TRUCKS OR CARS

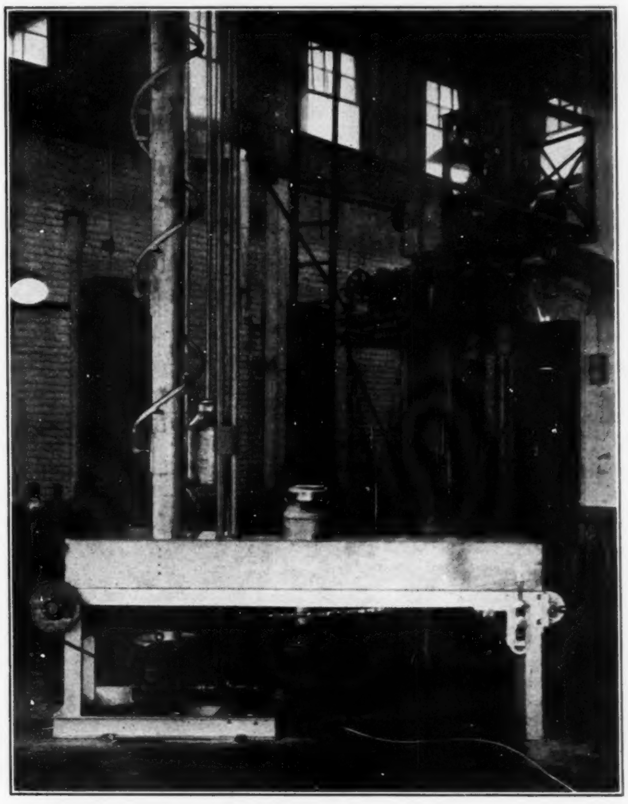


FIG. 4 DISCHARGE SECTION OF CAN DESCENDER

cables over a drum and idler sheaves. The truck approaches the cable reel and the pulling unit is set in reverse, allowing the cable to run out on each side. It is then fastened to a spindle, which is run through the reel, and the lever is thrown so that the pulling unit draws the reel toward the truck. The back end of the truck rests on the ground when the reel is not on the platform. The

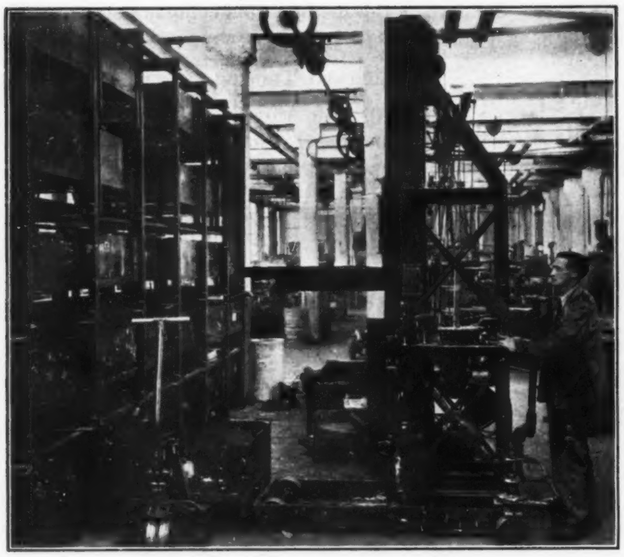


FIG. 5 ELECTRICALLY OPERATED STACKER FOR STORING BOX SKIDS

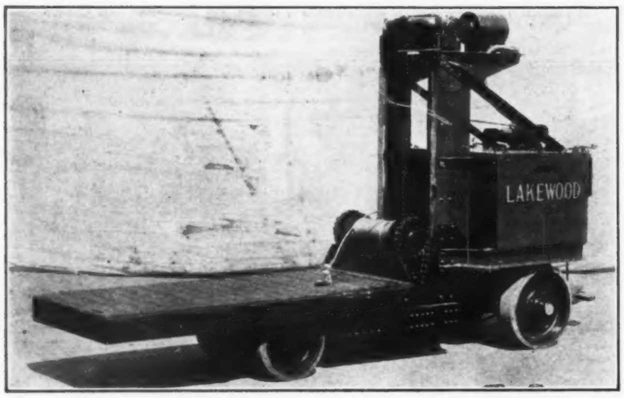


FIG. 6 TIER LIFT TRUCK WITH MOTOR-DRIVEN WINCH FOR LOADING HEAVY MATERIAL ON PLATFORM

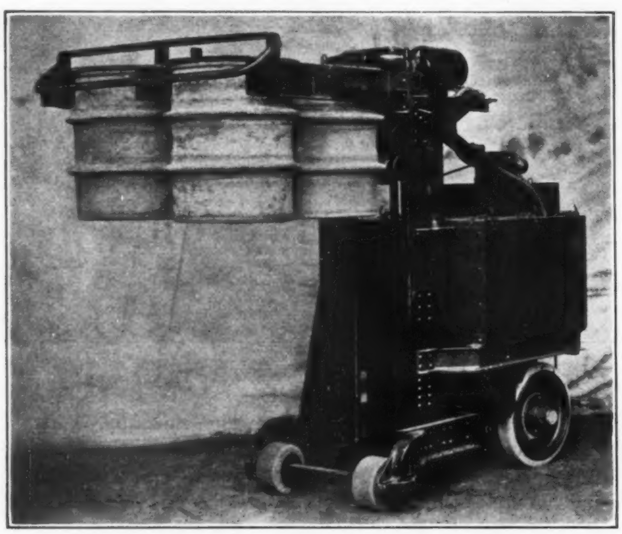


FIG. 7 SPECIAL TRUCK FOR HANDLING STEEL DRUMS

FIG. 8 LIGHT GANTRY CRANE FOR MACHINE-SHOP USE

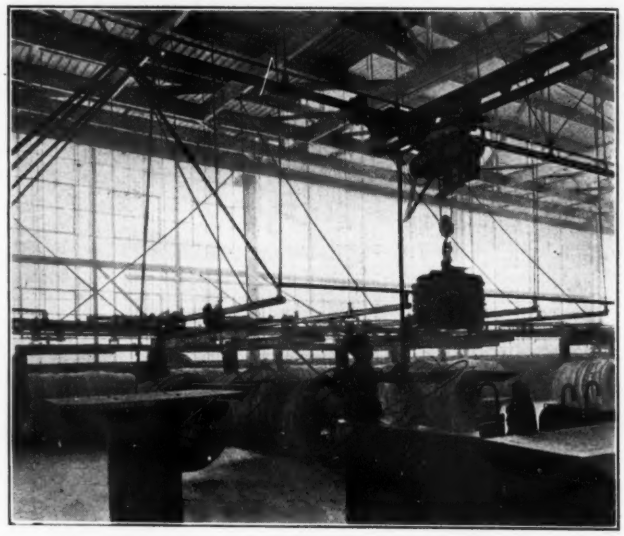


FIG. 9 HAIRPIN-HOOK FLIPPING DEVICE FOR USE IN WIRE MILLS

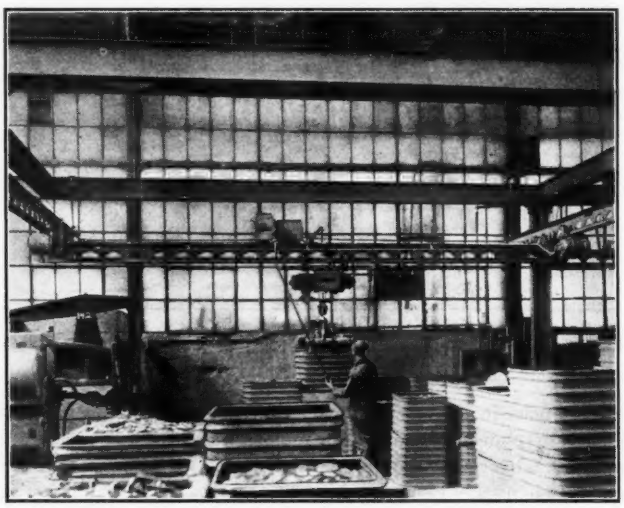


FIG. 10 POWER-OPERATED TRANSFER BRIDGE WHICH LOCKS AT BOTH ENDS WITH DISCHARGE POINTS AND PERMITS MOVING THE HOIST OFF EITHER END

action of the reel rolling past the center of the pivot in this platform causes the platform to rise into the position shown in the photograph. In this manner, very large and heavy cable reels are transported rapidly and with very little labor.

Fig. 2 shows a 6000-lb. low-platform, low-lift electric industrial truck upon which is mounted a 1500-lb.-capacity crane. This truck is primarily a low-lift skid-carrying truck having a platform lift of $4^1/_2$ in. The truck is shown with its own platform loaded, having been loaded by the crane, and an additional load on the crane hook. The articles shown being transported are marine engines, and it was not found necessary by the user to make use of skids in the transportation of this material.

Fig. 3 shows a portable barrel and drum loader for elevating filled drums from the shipping floor to trucks or cars.

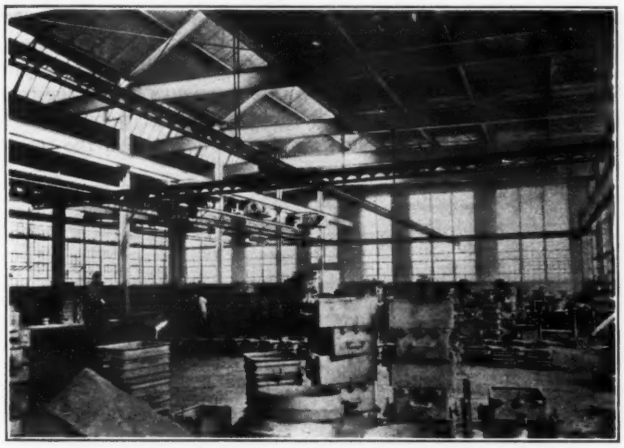


Fig. 11 Multi-Runway Type of Overhead Crane

Fig. 4 shows a milk-can or ice-cream-can descender that has been developed and is used as a power descender to convey filled or empty milk cans or ice-cream cans from upper to lower levels. In ice-cream plants very often the freezers are located on upper levels and it is necessary to lower the can of frozen cream from the freezer to the hardening rooms below. This type of unit fits into this need very completely.

The newly developed high-lift truck for the purpose of icing pullman dining cars has been recently placed in service at Buffalo. Using this truck, two men can ice 18 dining cars in $2^1/_2$ hours, whereas it formerly took 6 men 8 hours each to ice 15 cars. This truck has a high body which lifts up, loaded with ice, to the height of the dining car. It is only necessary for the men to put the ice into the icing compartment. The body can then be lowered from a controller located on the high-lift body.

This year there has been brought out a truck, the battery of which is mounted above the deck directly over the front wheels next to the dash. In this position it acts as a counterweight for the overhung loads for which this machine was designed, i.e., cranes with extensible topping-lift booms, and for the vertical elevating mechanism on which can be mounted shovels, crane arms, rams, stacking tables, and devices for stacking both cylindrical and rectangular packages. The mounting of these various devices is so made as to permit changing from one to another in a couple of minutes. This machine has the same wheel units, power units, steering mechanism, and control as were used on the older line, and these are therefore interchangeable between the two types of truck. The new trucks are made in three sizes, having 36-, 48-, and 60-in. wheelbase lengths. When equipped with a telescopic topping-lift boom, there are two power units mounted over the battery, one for raising the boom and the other for hoisting the hook. When so equipped they will handle 3600, 4800, and 6000 lb. at high speed over ordinary street pavements or on cinder-filled yard areas. To change from the shovel to the ram or any of the other tools used with this machine, it is necessary only to cast the rope off the equalizing bar and pull out the hinge pin at the bottom of the crosshead.

A similar elevating mechanism has also been brought out in the form of an attachment to the jack-lift truck which has been made for years. This attachment automatically locks to the frame of the truck, and then the jacks raise the attachment to the operating position in exactly the same way as the crane attachment which has been used with this truck for years.

Among the interesting jobs which these trucks have done this past year are the complete handling, mechanically, of freight on one of the Brooklyn, N. Y., piers. The use of hand trucks has been entirely eliminated on this pier, and the savings have been very substantial. At Barranquilla, Colombia, S. A., it has been found that, in spite of the fact that very cheap native labor is available, the two trucks which are used for handling the freight between railroad cars and storage and the shallow-draft river boats, have been paying for themselves every three months.

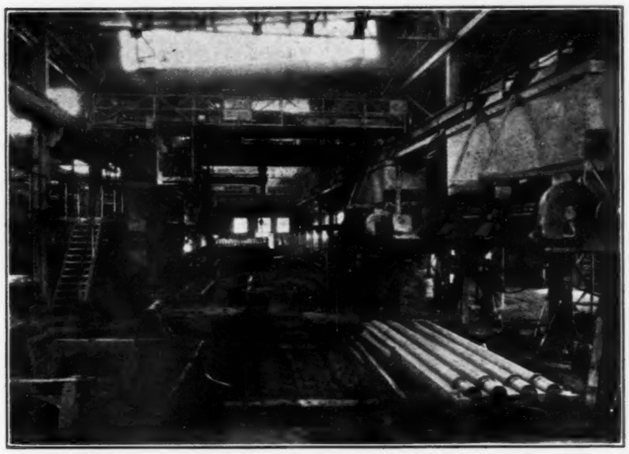


Fig. 12 Foundry Arrangements for Casting Iron Pipe Horizontally

A new truck has been developed known as the foot-lift truck. This truck enables the operator to elevate the load by using the full weight of his body, rather than calling into play his back and stomach muscles, which are used when the load is elevated with the steering handle. The foot pedal is so designed that it automatically engages with the load-elevating means when depressed, and automatically disengages when it is returned to normal operating position. The room required to operate this truck is much less than with any other type, as it is necessary only to provide sufficient space for the operator to stand in front of the truck, whereas on the handle type it is necessary to have aisle room to bring the handle practically to the floor in raising the load.

Where standard box skids are used for handling material through machine processes by means of a jack-lift truck, the "Jack-Rack-Stack" system shown in Fig. 5 has been successfully used. For storage, they are racked with the electrically operated stacker shown in the illustration. Units weighing from 1000 to 2000 lb. are easily handled in this way by one operator. A saving of space is at once apparent, as the five tiers of skid boxes are handled from a single aisle.

Fig. 6 shows a new tier lift truck which has recently been developed. This truck has a motor-driven winch mounted at the rear of the elevating platform for loading dies and other heavy

material on the truck. This mechanism raises and lowers with the elevating platform.

Fig. 7 shows a recently designed machine for handling steel drums. The drums are loaded in box cars with this machine and are taken out of cars and stored two high in the warehouse. There has been a great saving in labor through the use of this particular machine, as the drums illustrated are filled with a paste used for making storage-battery plates and consequently are very heavy. Formerly one man was required to handle one

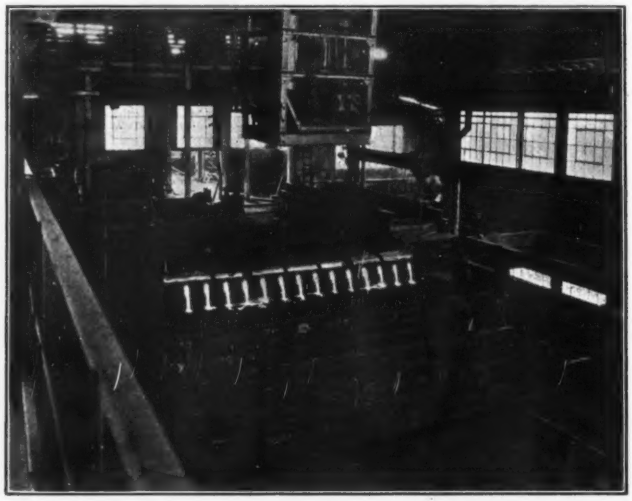


FIG. 13 MULTIPLE-LIPPED LADLE FOR POURING METAL IN HORIZONTAL PIPE MOLDS, AND CRANES FOR HANDLING FLASKS AFTER THEY ARE SHAKEN OUT

FIG. 14 MOTOR BRACKETS HANDLED ON VERTICAL SPINDLES BETWEEN MACHINING OPERATIONS

drum at a time, while the new machine is built to handle four drums at three times the speed of the man with the hand truck.

Fig. 8 shows what has been developed within the past year in the way of a gantry crane which can be moved with ease sufficient to warrant its use in a great many machine shops throughout the country. This crane has ball bearings on both the lower leg and also on the overhead half of the crane, and is so light and so designed that one-ton or two-ton loads can be picked up by the electric hoist at any point on the crane, and the entire crane moved by pushing on the load.

The "hairpin-hook flipping device" shown in Fig. 9 has been developed to supplant the practice, usual in wire mills, of moving material through the plant on floor-operated trucks, then removing each coil of wire from the truck and placing it on the reel before the wire is drawn. A flipper is installed on the end of a hairpin hook, and by properly applying this flipper, wire can be moved through the mill on a hairpin hook of this size in quantities of about 3000 lb. to the hook, and these hooks pushed in front of the wire-drawing benches, as shown in the figure, where the wire is flipped off the end of the hook without rehandling in the wire mill. The first installation of this kind was completed this last summer.

CRANES AND CONVEYORS

Fig. 10 shows a power-operated transfer bridge which is the result of several years of experiment in an effort to develop a transfer bridge which will lock at both ends with discharge points, and permit the hoist to move off either or both ends, as the case may be.

Fig. 11 illustrates the development of the multi-runway type of crane. The advantages of the three runways lies in the fact that by dividing the span of the crane in three sections, a much lighter crane can be furnished for a given load, with the result

FIG. 15 INDUSTRIAL-TRUCK SKID WITH SPECIALLY DESIGNED RACK FOR HANDLING ASSEMBLED MOTOR ROTORS

that the weight of the crane is reduced to a minimum. This reduction is a decided advantage in connection with the use of hand propulsion, because there is less deadweight to handle. The lighter cranes also have a decided advantage from the standpoint of building construction, because, with the use of the three-runway or multi-runway type of crane, the weight of the crane itself usually does not exceed the load which it is designed to carry.

A rapid and extensive use of conveyor-type systems for electroplating and deposition of metals has been reported. Estimates made by the manufacturers of this equipment indicate in many cases that the labor is cut 20 to 25 per cent, and at the same time the material is transported from one point in the plant to another for the next operation. When such a system takes the place of the old still-tank plating, the floor space is only a fraction of what was previously required and there is an almost complete elimination of the very sloppy condition usually prevailing in plating rooms. Another significant development in the metal-working field is the handling method adopted by the manufacturers of tinplate and sheet steel, who are loading this material into freight cars on standard skids by means of storage-battery industrial trucks so that the recipient of these goods at the other end of the line can unload them from the same skids with the same type

of truck and effect a tremendous saving in the handling cost.

A manufacturer of automobiles has adapted the fork-type truck to select bodies of the correct color to fit the specification of the chassis on the assembly line. Previously bodies have been taken from the conveyor horizontally, mechanically tilted on the cowl end, then revolved, picked up by a truck, and finally stood on end. The new method has reduced storage 66 per cent and has saved an investment of $250,000 which had been appropriated for new storage warehouse.

Fig. 12 shows a somewhat unique development in foundry handling. In the foreground of the picture there are patterns for four cast-iron pipes in one flask. These pipes are cast horizontally instead of vertically as is the usual custom. Furthermore, they are cast in green sand and with green-sand cores. Fig. 13 shows a multiple-lipped ladle that is used for pouring these pipes, and also the cranes which handle the flasks after they are shaken out.

A railway car and foundry company reports the recent development and installation of labor-saving devices, the most outstanding one being a "wheel breaker" used in breaking old wheels which are to be charged into cupolas at the foundry. These wheel breakers have now been developed to the point where they

Fig. 16 Truck for Handling Complete Motor Parts From Storage to Assembly Line

are practically automatic and have reduced the number of men required for this work from five to one, or at the most, two. The company is planning the installation of a chain conveyor for delivering the broken wheel sections from the breaker to the cupola charging platform. This step is expected to result in a further elimination of three more men.

The materials-handling installation made at a motor-car company's plant in Detroit in connection with a new forge shop for crankshafts is of interest in that it is among the first attempts to put forge-shop production on a continuous basis. This development has been made possible largely through the medium of materials-handling equipment. The crankshaft forge shop is laid out for straight-line, continuous production, with no stock of parts at any operation. Travel of the metal from the original bar stock, through all processes, and finally into the railroad car for shipment, is handled by various conveyor systems. There are five forging units, three heat-treating furnaces, and two pickling machines. This equipment handles 7500 crankshafts a day. The time required to convert bar stock into crankshafts, delivered at the shipping platform, is only $4^1/_2$ hours. In all, 225 men are employed in this new forge shop. The success of this development, and the reduction in total costs of forging it has brought about, open the way for the extension of the idea to other forged parts produced in quantity.

At another plant in Toledo, Ohio, a materials-handling installa-

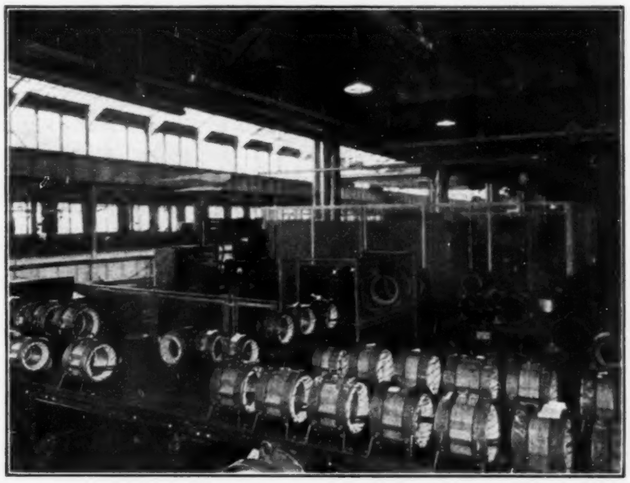


Fig. 17 Power-Driven Conveyor Used in Testing Wound Motor Stators

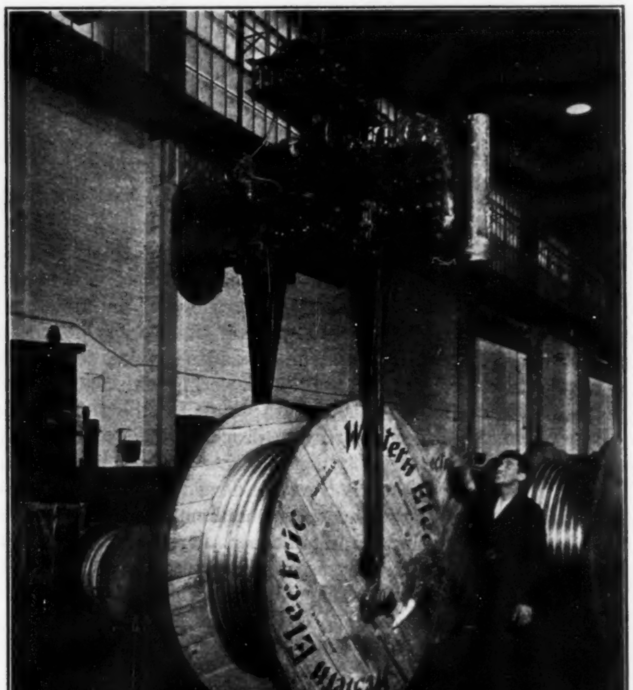


Fig. 18 New Crane Grapple With Power Opening and Closing and Power Swivel for Handling Lead-Covered-Cable Reels With an Overhead Crane

tion was made which has revolutionized the manufacture of transmissions at the plant and reduced the floor space required for the output to about one-third of the former area.

Materials-handling developments at the East Pittsburgh plant of an electrical-equipment manufacturer have been along the

line of special equipment made to fit some certain job. This may or may not fit in with other standard materials-handling equipment, such as conveyors or industrial trucks. In attacking many of the problems in this plant, where so-called standard methods of materials handling cannot be applied, careful study usually shows a method of meeting the problem which results in lessened handling costs. Industrial electric trucks are being applied to an increasing extent, and with definite advantages on many lines of work. The flexibility of the truck is so great that it fits in excellently with the needs of such a plant, where the line of work varies from a small screw-machine part to a generator as big as a house. By using the trucks as a motive power for industrial trailers in addition to their own pay load, the company has effected considerable economies, and has also taken care of peak-production loads without the addition of extra truck equipment.

Motor brackets are handled on spindles between operations performed on automatic machines, as shown in Fig. 14. These occupy little floor space and may be adapted for quick handling by means of chain conveyors.

The adaptation of an industrial-truck skid with a specially designed rack for handling assembled motor rotors is shown in Fig. 15. This method keeps the rotors clean and free from damage and allows bulk handling from and to storage.

Fig. 16 shows a truck handling a number of complete motor parts which are secured from storage and conveyed to the assembly line. From the truck they are placed on a power conveyor where final assembly and test are made.

A power-driven conveyor used in the testing of wound motor stators is shown in Fig. 17.

A New Jersey manufacturer reports the use of a new crane grapple with power opening and closing and power swivel for handling lead-covered-cable reels with an overhead crane, shown in Fig. 18. This grapple eliminates the necessity of having a floor man to insert the plugs in the hub centers.

This company also reports the employment of all-water shipment of bare copper wire from Hastings, N. Y., to its plant at Kearny, at a marked saving over rail or truck shipment. This method involves the use of several hundred new box skids, seven flat cars in the yard, and a high-lift electric truck. With the exception of a manual inspection operation, the wire is not touched until it is unloaded at the insulating machine.

Skid Shipment

The Department of Commerce reports that this method of shipment has continued to grow, as well as the use of various types of containers for rail and water shipping. In some cases skid shipment has shown a very remarkable saving, one large paper company reporting a reduction in labor costs of 90 per cent.

E. D. Smith, *Chairman*.
Progress Report Committee of the Materials-Handling Division.

Progress in Oil- and Gas-Power Engineering*

Contributed by the Oil and Gas Power Division

Executive Committee: E. J. Kates, *Chairman*, L. H. Morrison, *Secretary*, H. A. Pratt, Harte Cooke, and L. M. Goldsmith

Recent oil-engine developments have been revolutionary—during the last year oil engines of two widely different designs "went up in the air" in airplanes; a large British airship propelled with oil engines has just been commissioned; a 24,000-hp. stand-by and peak-load stationary power plant was recently started; a battleship with 50,000-s.hp. propelling plant has been laid down; and for the 100,000-hp. power plant of the new electrically propelled White Star liner, oil engines are being seriously considered. The principal reason for much of the progress has been the development of means to materially reduce weight and space requirements of oil engines and thus make them lighter and cheaper, thereby widening their field of application. Higher piston and rotative speeds, airless injection of fuel, supercharging of four-cycle engines, double-acting cylinder construction, special types of frame construction, improved materials—all of these have contributed to each individual success.

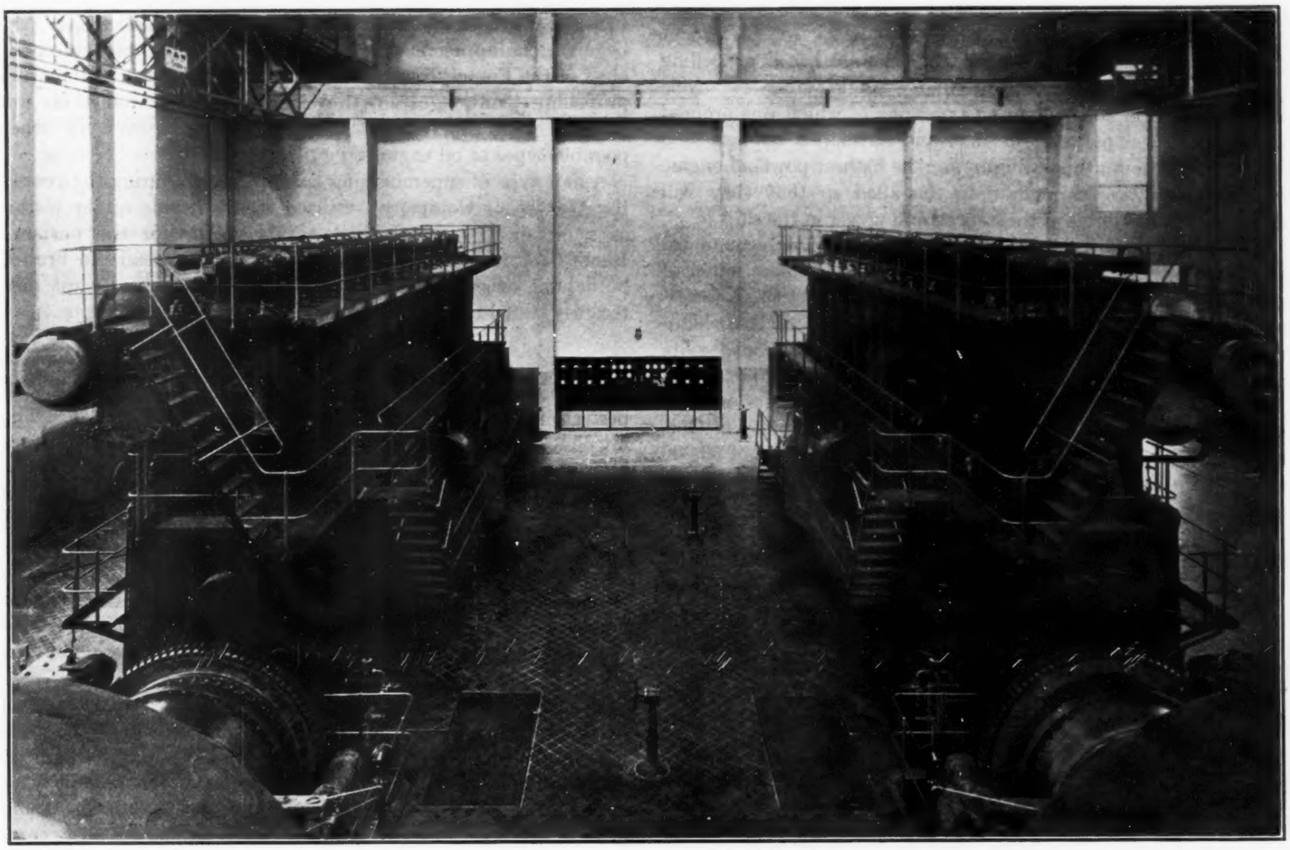
Aircraft Oil Engines

The Attendu experimental two-cylinder two-cycle engine,[2] built some time ago for the Navy Department in the hope of developing it for airship propulsion, gave disappointing results as to fuel consumption and thereby forfeited one of the expected advantages in large cruising radius—yet the new Packard airplane engine was the indirect result of this experiment. This engine, which first flew on September 19, 1928, later made the epochal 650-mile trip from Detroit to Langley Field on May 13, 1929, at a fuel cost for the trip of \$4.68 instead of \$25 for gasoline. This radial 9-cylinder engine develops 200 hp. at 2000 r.p.m. and weighs less than 3 lb. per b.hp.[1] A single automatic combination inlet-exhaust valve is fitted in each cylinder crown, and the propeller airstream is relied on to blow away the exhaust gases which the pistons force out and fill the cylinder on the suction stroke. A small single-plunger fuel pump is mounted ahead of each cylinder with a short pipe to the single injection valve. A special factory has been built by the Packard Company for the economical manufacture of these engines on a production basis. Henry Ford has also taken up experimenting with an oil engine for airplanes.

Last February in Germany another oil engine made several successful flights. Professor Junkers[2] modified his well-known opposed-piston construction to use two separate crankshafts with the air propeller driven by both through 1:1.4 reduction gearing. Here the lack of cylinder heads, perfect scavenging, and equally perfect balance permitted the building of a six-cylinder 700-hp. engine running at 1600 r.p.m. on a total dry weight of 1780 lb. or about $2^1/_2$ lb. per hp., while its fuel consumption on test is claimed to be 0.397 lb. per b.hp-hr.

The British airship *R-101*,[3] equipped with five Beardmore oil engines, made her maiden flight on October 14, 1929. These engines are of the four-cycle type and have eight $8^1/_4$-in. bore, 12-in. stroke cylinders designed to develop 650 b.hp. at 1000 r.p.m., while their weight is 4600 lb. with cast-steel crankcases and 3600 lb. with aluminum ones. Unfortunately, considerable trouble from torsional vibration has forced the reduction of their rated speed—and therefore horsepower—and increased their

* Numbered references in the text relate to the Bibliography at the end of the report.



24,000-Hp. Peak-Load M.A.N. Oil-Engine Plant at Henningsdorf, Near Berlin, Germany

unit weight. Airless fuel injection is used, and their fuel consumption is claimed to be 0.385 lb. per b.hp-hr.

Marine Oil Engines

The year marked the completion of the second Dieselization program of the U. S. Shipping Board, so that now a total of twenty-three single-screw vessels constitute the nucleus of the motorized American merchant marine. Eleven ships are equipped with double-acting engines, of which four are Worthington two-cycle four-cylinder units, four more are powered with M.A.N.-type two-cycle four-cylinder engines, and the remaining three are of the McIntosh & Seymour four-cycle type, one four-cylinder and two five-cylinder units. Of the nine ships equipped with single-acting engines, six have Busch-Sulzer two-cycle six-cylinder engines, while three others have McIntosh & Seymour four-cycle six-cylinder engines.

The three remaining conversions finished during the year are electric-drive ships with four trunk-piston McIntosh & Seymour engines driving electric generators, and a single propelling motor of 4000 s.hp. at 60 r.p.m. The engines are of the single-acting four-cycle type, rated to develop 1280 b.hp. at 250 r.p.m. in eight cylinders of 20 in. bore and 24 in. stroke.

Private enterprise in the United States has been responsible for only one larger motorship—a freight and passenger ship for the American and South African Line in which two 2700-s.hp., 95-r.p.m., four-cylinder, Sun Doxford two-cycle, opposed-piston engines of 21.26 in. bore and 85.04 in. combined stroke constitute the propelling plant.

Foreign Marine Oil Engines

The rest of the world has appreciated the advantages of the marine oil engine to a much larger degree—not less than twenty-seven motor passenger liners of over 10,000 tons were reported under construction in Europe and Japan last July. Of these, 13 are to be propelled by single-acting two-cycle engines and 3 by double-acting two-cycle, 10 will have double-acting four-cycle machinery, while only one will have an engine of the single-acting four-cycle type. Out of all the merchant vessels under construction, about 1,400,000 tons or 49.5 per cent are motorships,[4] with 1,238,675 i.hp. in oil engines to propel them or 54 per cent of the total horsepower of their propelling plants.

Of all the numerous types of propelling plant the following outstanding examples are to be noted. The recently launched White Star passenger liner *Brittanic* will be propelled by two ten-cylinder four-cycle double-acting engines of the Burmeister & Wain type, developing 10,000 s.hp. at 110 r.p.m. This is the largest engine with the same 33.071-in. bore by 59.055-in. stroke cylinder which was originally installed on the M.S. *Gripsholm* and of which more than 400,000 i.hp. have been built since. The four Dutch liners now under construction are to be propelled by two ten-cylinder (30 in. × $52^3/_4$ in.) two-cycle single-acting Sulzer engines developing 7000 s.hp. at 100 r.p.m., although a larger cylinder size has been repeatedly built up to seven cylinders, developing 7040 s.hp. at 100 r.p.m.[5] The other two notable propelling plants are the geared oil engines installed in the North German Lloyd liners *St. Louis* and *Milwaukee*. These are twin-screw vessels with two-cycle double-acting M.A.N.-type engines developing 3100 s.hp. at 225 r.p.m. (*St. Louis*) in six working cylinders of 19.097 in. bore and 25.98 in. stroke, geared to each shaft through the Vulcan hydraulic coupling.[6] On the M.S. *Milwaukee* the engines are coupled to the reduction gear direct.

Naval Oil Engines

The French submarine tender *Jules Verne*[8] has a propelling plant consisting of two eight-cylinder single-acting two-cycle Sulzer engines of the submarine type, one of which was ordered for experimental purposes in 1924 and developed on test 7000 b.hp. at 280 r.p.m., thus being by far the highest-powered engine of this type. These engines are installed so that they will develop only six-tenths of their speed and power in the ship.

The German faith in the oil engine as the most economical source of power served to develop it also into the lightest source of power for naval ships. The three German cruisers, the *Koenigsberg*, *Karlsruhe*, and *Koeln*, recently commissioned, have high-speed oil-engine cruising units in addition to their 65,000-s.hp. steam-turbine plant.

The now famous *Ersatz Preussen* received much of its military value in speed, guns, and protection through the ability of German engineers to develop an oil-engine propelling plant of 50,000 s.hp. which is actually lighter than any steam-turbine plant available.

Stationary Power Plants and Economics of the Oil Engine

Of the many hundreds of various stationary oil-engine power plants, the most notable is no doubt the installation of two double-acting two-cycle M.A.N. engines in a stand-by and peak-load plant at Henningsdorf, near Berlin, which was started last August. The engines have working cylinders of 23.622 in. bore and 35.433 in. stroke and can develop 11,700 b.hp. at 215 r.p.m. on a reported fuel consumption of 0.381 lb. per b.hp-hr. The engine is by far the largest engine using mechanical injection of fuel, and weighs only 55 lb. per b.hp. The simplicity of these large units is truly inspiring, but their resulting low cost, said to be $48 per kw., is also very important. Furthermore, with one man on watch the entire output of the plant (23,400 b.hp.) can be developed on two or three minutes' notice.

Railway Service

A total of 105 oil-electric locomotives were in service or on order in the United States and Canada by September 1, 46 of which were ordered during the year, as well as 35 switching locomotives ordered at one time by the New York Central for its New York west-side yards. These latter, in addition to the standard 300-b.hp. Ingersoll-Rand engine, have a 219-cell, 17-ton Exide battery and are arranged to operate also with outside current coming either through third rail or from an overhead collector. Of considerable interest is the Krupp locomotive for the Boston & Maine, scheduled for delivery before the year is over, in which a mechanical transmission with automatically operated magnetic clutches is used.

The Canadian National Railway has recently put into commission a large articulated locomotive housing in each cab one twelve-cylinder vee-type Beardmore four-cycle engine rated at 1340 b.hp. at 800 r.p.m.[2]

Supercharging and Two-Cycle vs. Four-Cycle

The old rivalry between two-cycle and four-cycle types of oil engine continues. While even the Burmeister & Wain Company has developed a large double-acting two-cycle marine engine and another single-acting two-cycle high-speed engine which is being tried out in a locomotive and in a fishing boat; while the Werkspoor Company, and the Stabilimento Triestino (Italian licensee of Burmeister & Wain) have taken out licenses to build Sulzer two-cycle engines and Vickers has arranged to build two-cycle double-acting M.A.N. engines—while all of this seems to point one way, nevertheless the substantial development of supercharging of four-cycle engines gives this type of engine an advantage which cannot be overlooked, and its qualities have just begun to be appreciated. A recent paper[9] by the engineer-in-chief of the French Navy shows that even for a larger submarine propelling plant, substantial weight and space reductions are possible with supercharged four-cycle engines over all other possible types of oil engines.

A new type of supercharging became known during the year—the Werkspoor Company[11] utilized the underside of the piston of a crosshead type of single-acting engine for the purpose. Buchi[10] at the Swiss Locomotive Works and Rateau[12] in France both built exhaust-gas-driven turbo-blowers. The largest unit recently tested by the former comprised a 3000-b.hp. engine.

New Materials and Processes

The progress in the art of oil-engine building owes much to the perfection of the materials available for construction. The introduction of "nitralloy" steels having a glass-hard surface with a tough core has opened new possibilities for crankshafts (so far only small ones have been used), cams, pump plungers, and gears. Chromium plating was used in the Worthington engines for the Shipping Board, to produce a hard rubbing surface on a piston rod without affecting the elasticity necessary to withstand shocks of explosions. The extension of this process to cylinder liners is being perfected, and the building up of worn parts of plungers, valve stems, etc. may prove to be quite important for quick repairs.

The process of building up a lower cylinder head from steel parts by a copper soldering process[13] introduced by the German A.E.G. Co. for their large double-acting two-cycle engines,[7] will no doubt aid considerably in enhancing the reliability of large marine oil engines. Much experimental work is also being done to make welding of crankcases out of sheet-steel parts commercially feasible.

Oil-Engine Research

Spray research continues at the N.A.C.A. laboratories at Langley Field,[19] at Penn State College, and at the A.E.G. laboratories in Berlin. The effect of injection-tube length and diameter, injection pressure, valve-opening pressure, and initial tube pressure on the injection lag are being studied by means of spray photography at Langley Field. Work on the determination of the coefficient of discharge for small, round orifices as well as for multiple-orifice injection valves, continues.[14, 15, 16] The A.E.G. laboratories report investigations in progress on the size of oil drops in a fuel spray.

A very interesting method to determine whether engine, fuel, or lubricating oil is responsible for the difficulties experienced in burning certain varieties of fuel has been published by H. Jentzsch,[17] who developed an apparatus for testing the suitability of a given fuel by measuring the heat and oxygen required for self-ignition.

Gas Engines

The distribution of natural gas requires much power in gas-driven gas compressors—for the large pipe line from Louisiana to St. Louis twelve Worthington 1000-b.hp. units were installed during the year. The largest by-product source of energy is blast-furnace gas, and the Bethlehem Steel Company reports the installation of five of their 47-in. × 84-in. × 60-in. tandem gas-driven blowing engines. During the year the Allis-Chalmers Company designed and built two of their largest (60-in. × 64-in. cylinders) twin tandem gas engines, to be operated also on blast-furnace gas. The first plant in this country to be run successfully on sewage gas has been installed in Charlotte, N. C.,[18] where one 55-b.hp. and one 225-hp. standard Sterling gasoline engines were used. The Deutz Company installed an 1120-

b.hp. power plant near Berlin working on sewage gas, and has another similar plant of 2100 hp. in course of construction.

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Progress in the Petroleum Industry

Contributed by the Petroleum Division

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IN PREPARING its Progress Report for the year 1929, the Petroleum Division has confined its attention to two fields: namely, pipe-line transportation and refining. These have been reported on by engineers especially acquainted with their respective subjects, and their findings appear below.

PROGRESS IN PIPE-LINE TRANSPORTATION[1]

The last three years have marked a transitional period in the pipe-line industry from old and traditional methods to new and better ones. This change has come about in the industry largely through the cooperative efforts of the engineers both in the petroleum industries and those allied with it in the manufacturing of the products and commodities which it uses. The mechanical engineer has been recognized in the petroleum industry by the executives of the various companies, and much of the progress that has occurred during the last three years can be attributed to the efforts of the engineer to adopt new methods. It is the purpose of this report to summarize some of the outstanding developments during the year 1929 in the oil-pipe-line industry.

LINE PIPE

One of the outstanding changes that has occurred in pipe-line equipment has been in line pipe. Three years ago the industry was following the same practice that it had been using for years: lap-welded pipe made of low-carbon steel with a tensile strength of about 48,000 lb. was used almost exclusively. At that time the screwed coupling was used for joining the pipe together. About two years ago seamless line pipe made of steel with a tensile strength of about 48,000 lb. was used in some welded lines which were then being laid. Immediately following the laying of these lines some seamless line pipe with a higher percentage of carbon and with a tensile strength of about 64,000 lb. was used in a long welded line. Since that time seamless line pipe has been used extensively for welded pipe lines. The merit of this class of pipe has been proved by the lack of failures either in tests or in the use since that time. A welded line 200 miles in length was tested without a failure, and no failures have occurred during its two years of service either in the pipe or in the oxy-acetylene welds joining the pipe. During the last year a large amount of autogenous electrically welded pipe has been used in trunk lines in diameter up to 12 in. This class of pipe is lighter in weight than the standard lap-welded or seamless pipe. The autogenous-welded pipe is made of steel with a carbon percentage of from 0.25 to 0.35 and a tensile strength of 64,000 to 72,000 lb. The wall thickness of the pipe is about $^1/_4$ in. The recent tests on a long line in which autogenous-welded pipe was used have proved it satisfactory.

It is understood that one of the steel companies will soon be ready to put on the market a pipe which will be welded by an electrical flash method. The last two years have marked the passing of lap-welded pipe for high-pressure trunk lines. There will be some lap-welded pipe used when the seamless and the autogenous pipe are not available, but less than formerly.

Although the seamless pipe has cost a little more than the lap-welded pipe, it is believed that its merits justify the small increase in cost. A distinct advantage of the seamless pipe is that it does not have welded longitudinal joints and consequently will be considerably less subject to failure than welded pipe. Other advantages in the use of seamless pipe are that it can be worked at higher pressures on account of the efficiency of the joint over lap-welded pipe, and it can be made in higher-carbon steels with higher tensile strength. The use of seamless pipe will permit much higher working pressures than could be obtained with low-carbon lap-welded pipe, which cannot be made in the higher-carbon steel. It will be seen, then, that with higher permissible working pressures the pumping stations can be spaced farther apart and consequently a smaller number of them required than on the standard lap-welded line. The use of this pipe, then, will permit either greater distances between stations or greater capacity between stations as they are spaced on present lap-welded lines. The use of this seamless pipe should mean a lower overall investment and a considerably reduced operating cost. It is believed that when designing new lines, the higher-carbon steel, of a tensile strength of 64,000 lb. minimum, should be used at least on the high-pressure ends of pipe lines in order to take advantage of the higher per-

[1] Prepared by William G. Heltzel.

missible operating pressure, and in case it is desired to operate a line at a lower pressure, the "reserve strength" in the pipe would be available in the future if additional capacities were required. A design using the higher-tensile-strength pipe on the high-pressure end would permit additional capacity in the future, when it was needed, making it unnecessary to build loops to give that additional capacity.

The electrically welded pipe has proved its merit in service and it is believed that the joint will prove reliable. This reference pertains to the longitudinal weld along the pipe as well as to the circumferential weld made in the field to join the lengths of pipe together. What has been said as to the merit of high-tensile seamless pipe pertains to the autogenous-welded high-tensile-strength pipe also. The advantage of the autogenous-welded pipe is that it is lighter in weight per foot and consequently the freight cost is less, the stringing and laying cost is less, and the overall investment is smaller. The one question about the autogenous-welded pipe of $^1/_4$ in. thickness is that of corrosion. Engineers are asking themselves, "Will the pipe of $^1/_4$-in. wall thickness have the same life as the standard pipe with heavier walls?" It is realized that soil corrosion will cause failures in both classes of pipe, but what the relative life is for pipe of different wall thicknesses is not known. Some engineers are making use of pipe with lighter walls, hoping that they can prevent the metal from corroding by applying protective coatings. Another advantage of the pipe with thinner walls is that a greater capacity should be obtained on account of the larger inside diameter for the same normal size of the pipe.

In the design of new pipe lines the trend is toward the use of higher tensile strength, thinner walls, larger diameters, and longer lengths of pipe. It is becoming common practice in oil-pipe-line construction to use pipe in lengths of from 40 to 45 ft.

Pipe Joints and Fittings

The welding of pipe lines has brought about a remarkable change also in the type of joints used. In the pipe lines laid previous to about three years ago the screwed joint was universally used. However, few or no trunk lines are laid now with screwed joints, because the pipe is joined together either by gas or electric welding. The screwed joint has almost become obsolete for trunk-line work; however, it will continue to be used to some extent for temporary field gathering lines.

Until recent years the screwed joint was the best type of joint available for construction work, and consequently all of the old lines are joined by screwed couplings. The history of these old lines is filled with repeated failures in the couplings. The lines have pulled out of the joints and leakage has occurred through the screwed coupling when the line was expanding or contracting. The result has been that large losses of oil have occurred on account of the screwed joint. It has been learned recently also that the leakage of oil from the screwed coupling has resulted indirectly in severe corrosion of the lines where leaks have occurred. It is becoming common practice among pipe-line companies, when taking up old lines that are to be relaid, to cut out the coupling and threads and bevel the pipe for welding. And when old lines are uncovered and reconditioned it is the policy of some of the companies to put a light weld on each side of the coupling to prevent leakage and, indirectly, corrosion. The four methods used at present for joining welded pipe are:

a The butt joint with the ends of the pipe beveled at 45 deg. for gas welding. This type of joint is used in laying pipe with a standard wall thickness, and the joints usually are gas welded.

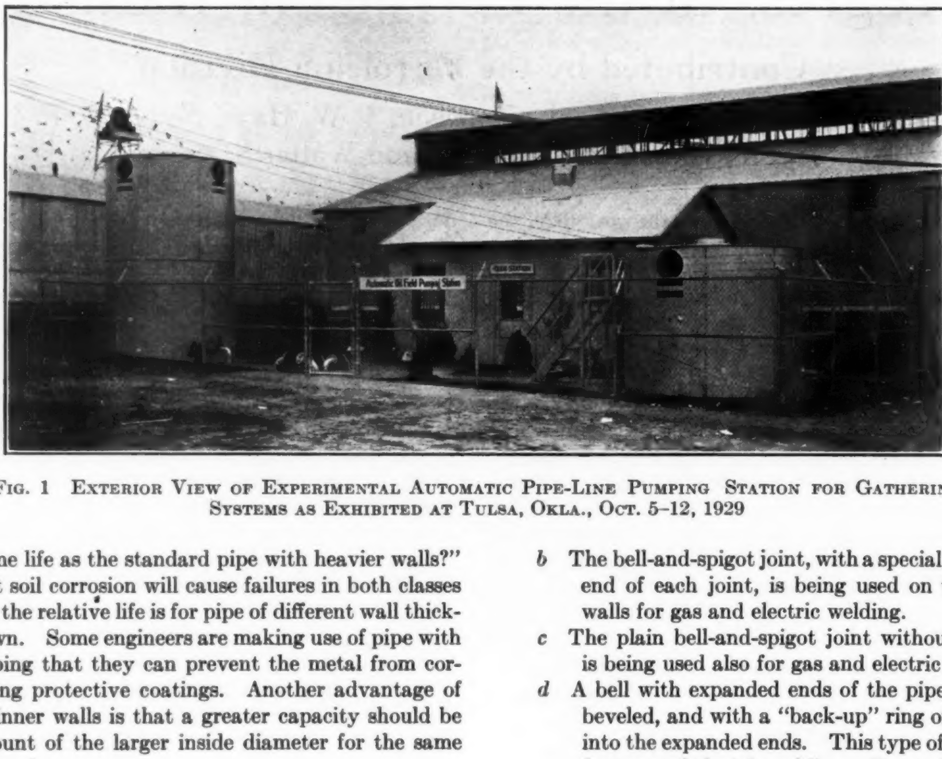


Fig. 1 Exterior View of Experimental Automatic Pipe-Line Pumping Station for Gathering Systems as Exhibited at Tulsa, Okla., Oct. 5–12, 1929

b The bell-and-spigot joint, with a special dam on the spigot end of each joint, is being used on the pipe of lighter walls for gas and electric welding.

c The plain bell-and-spigot joint without the special dam is being used also for gas and electric welding.

d A bell with expanded ends of the pipe butting together, beveled, and with a "back-up" ring on the inside fitting into the expanded ends. This type of joint is being used for gas and electric welding. It provides for good welding penetration and gives good strength.

It is understood that some development work has been done on another type of joint. This joint is made in the field by a hydraulic machine, which recesses a ring groove in the wall of the spigot end of a joint of pipe; the bell joint is then fitted over the spigot end and by hydraulic pressure a ring groove is recessed in the bell wall to fit into the corresponding recess in the wall of the spigot where they join, thereby providing strength in the joint against pulling apart. After the pieces of pipe are joined by the hydraulic recessing, the bell end is welded to the spigot end of the other joint of pipe.

A few years ago it was common practice to use heavy cast-iron fittings consisting of ells, tees, flanges, manifold barrels, valves, castings, etc. The use of welding has brought about a beneficial change in fittings for pipe-line work. The heavy cast-iron fittings that were used several years ago are obsolete and ready to be

junked. It is no longer necessary to carry in stock the large quantity of fittings that was found in the average warehouse several years ago, for it is now possible to weld the type of fitting desired from pipe. There has come on the market recently a special bend, or turn, with uniform wall thicknesses that can be used advantageously in pipe-line construction work. Forged steel flanges, and more recently forged steel flanges with welded necks as a part of the forging, have replaced the cast-iron flanges which formerly caused so much trouble through their frequent failures. It is common practice now to use flanges welded into lines rather than to use screwed flanges.

Welded Pipe Lines

One of the most remarkable developments in the construction of pipe lines during the last three years has been the welding together of the joints. The most marked development during the year 1929 has been the use of electric welding for the joining of pipe together in the case of trunk lines. It is known now that the gas-welded line is reliable, and it is believed that the electrically welded line will prove likewise.

When the first gas-welded lines were laid, there was some question about the reliability of the welds and the possibility of "icicles" on the inside of the weld holding up the scrapers in their passage through the lines. In the construction of 200 miles of 8-in. line, not one failure occurred in the tests. After two years of operating no failure has occurred. A leak has not been reported on this line either on the test or in operation. In a line about 400 miles long about five failures occurred when the line was tested. These failures resulted from the pipe's being roughly handled when the pipe line was put into the ditch. However, no failures occurred on this line during the following year of operation.

Scrapers have been put through the entire length of this 600 miles of pipe line, and in no case has a scraper been held up on account of icicles at the welds. It is believed that the electrically welded line will give results equally reliable. Welding has eliminated the many leaks and the loss of oil that occurred in the lines with screwed joints. Welding should result in a much smaller leakage cost, and certainly it will eliminate much of the corrosion caused by the many oil leaks from the couplings. As a result of the reliability of the welded pipe line, higher operating pressures can be carried and greater security of transportation is assured. It may be that the reliability of the welded line will pave the way to automatic pumping stations.

Pumping-Station Machinery

About 12 years ago the Diesel engine began to replace the steam engine for pipe-line pumping. The pipe lines built since that time have pumping stations equipped with only Diesel engines. However, on the old lines a few steam engines remain. The Diesel unit gave much higher efficiency and consequently it was exclusively used on new pipe lines up until about two years ago. The year 1928 marked the advent of electric-motor-driven pipe-line pumps for oil-trunk-line service. There has been considerable controversy over the economical use of electric motors for pipe-line pumping, and that question has not yet been settled. It is known, however, now that both motor-driven centrifugal and motor-driven reciprocating pumps have proved reliable in operation. If it can be proved that it is more economical, or equally economical, to use electric motors than oil engines for driving pipe-line pumps, then the trend will certainly be toward the electrification of pipe-line pumping stations for newly constructed lines. It will hardly be economical to convert the present oil-engine units in old pipe-line pumping stations to electrical units since the fixed charge is already established.

Where existing pipe-line systems are being increased in capacity, the trend is toward replacing smaller Diesel engines at the pumping stations with larger units. The early oil engines for pipe lines were built in capacities up to 250 and 300 hp., but the more recent installations are units of 750 to 800 hp. The smaller units in the pumping stations are being replaced when the capacity of the line is increased on account of the increased maintenance and labor cost on a number of smaller units. Just as the trend is toward large oil engines, so it is also toward the use of large reciprocating pumps. Some of the recent installations of reciprocating pumps have been units with capacities of 42,000 to 46,000 bbl. per 24 hr. The features of these pumps as compared with the earlier type of pipe-line pumps are sturdier frames, larger bearings, and better gearing.

Considerable trouble has been experienced in pipe-line pumping with the breakage of discharge lines between pipe-line manifolds and the discharge pumps, and of pump parts and other equipment. Some recent investigations have shown that this breakage has resulted from pressure surges in the pipe lines. It has been recommended that air chambers on the discharge side of the pump be used to eliminate this damage. Many of the pipe-line companies have accepted these recommendations, and much of the trouble has been eliminated.

The trend is toward the use of motor-driven pumps for field gathering stations, which have a comparatively short operating life as compared with trunk-line stations. It has been found that the station with a low investment cost is more desirable for field gathering stations on account of the fact that in the method used in the oil fields today a large amount of flush oil is produced within a comparatively short time. The production of a large amount of oil in a short interval of time means a larger gathering system and more stations than were used when fields were developed gradually. These pumping stations for gathering systems have a comparatively short life, and the investment cost must be kept low. Both motor-driven centrifugal and the reciprocating pumps are being used in these field stations. However, it has been found that the reciprocating unit is more desirable on account of its higher overall efficiency. It is probable that the future field gathering stations will have motor-driven reciprocating pumps with centrifugal pumps as spares or for emergency use.

Automatic Pipe-Line Pumping Stations

The use of the electric motor for pipe-line pumping stations has brought about the possible use of automatic control for these stations. It is believed now that automatic control can be used for smaller pipe-line gathering stations. It is believed, further, that after automatic-control equipment has been worked out for this class of station and more confidence is gained in it through reliability of operation, automatic control can be used for trunk-line work, especially where the motor-driven centrifugal pump is employed.

At the recent International Petroleum Exposition held in Tulsa, October 5 to 12, 1929, a full-sized experimental automatic oil-field pumping station was on exhibit. This exhibit was arranged through the Scientific and Technical Committee of the Exposition and was received favorably by pipe-line men, but it was pointed out that certain features had yet to be worked out to make the station fully automatic and foolproof. The exhibit, which is shown in Figs. 1 and 2, demonstrated the following features of automatic control:

a Starting up and shutting down motor-driven pump by a liquid-level instrument actuated by the pressure head exerted by the fluid in the tank.

b Automatically controlled and electrically operated gate valves on the discharge and filling lines.

c Automatic shutting down of motor-driven pump by

high- and low-pressure protective gages. This automatic feature was used to demonstrate how the motor-driven pump could be shut down for an excessive increase of pressure in the line or a drop of pressure in the line as a result of a break.

d Automatic starting and shutting down of the motor at a definite time by a time clock.

The information gained from the operation of this experimental station showed that it will be necessary to add the following automatic features of the station to make it foolproof.

a Automatic control of the motor-driven pump by a flow meter, such as the venturi. Thus it is believed that the shutting down of the pump can be made foolproof for a break in the line by using a pressure-protective equipment and a flow meter combined; for a drop in pressure or an increased delivery of fluid usually means a broken line. With a centrifugal pump a break can occur in a line without any drop in pressure being indicated on the recording pressure chart; it is characteristic of a centrifugal pump to maintain its pressure with an increased delivery when a break occurs, provided the break is not too near the pump. Therefore it is believed necessary to adapt the flow meter to shut down a centrifugal pump when a break occurs in a line giving an increased delivery, even though a drop in the pressure does not occur.

b An automatically controlled and electrically operated bypass valve must be developed for use on the discharge pump in starting up so that the pressure is built up gradually with the closing of the bypass valve.

c The proper functioning of this control equipment will depend upon the elimination of the pressure surges on the discharge side of the reciprocating pump. Therefore it is believed necessary to develop an automatically charged air chamber to damper the pressure vibrations.

d It is believed that some work should be done on remote control of pipe-line pumping stations.

Construction of Pipe Lines

Although the use of welding in pipe-line work has resulted in more reliable lines, it is taking more time to lay welded lines than was required to lay screwed pipe, although more labor-saving machinery has been used for this construction work than was used four or five years ago. One reason for this delay is probably that the men who laid screwed lines are yielding their places to younger men who are learning the practice of laying welded lines instead. It will probably take a few years for these men to eliminate the time delays in this construction work. Another element that enters into the laying of welded pipe lines is the weather. When the screwed lines were laid the pipe-line crews were on the job in all kinds of weather. Each man was at his post in the morning at the start, and carried on even in the most severe weather. Each man had his part and kept active throughout the day, and in that way could keep warm when the weather was cold. Conditions are a little different now with the crews laying welded lines. Less physical energy is required on the part of the men, and it is a common sight along pipe lines that are being laid in the winter to find men standing around fires to keep warm. This fault is not so much in the men as it is in the fact that the crews that laid screwed lines were organized differently from those that lay welded lines. Something must and will be done to speed up the construction of welded lines. Already developments have taken place in the speeding up of the electric welding, and it is likely that the time required to lay welded lines will be materially lessened during the coming year. Each year marks the use of additional and more improved labor-saving machines in the construction of oil pipe lines.

Pipe-Line Tankage

The pipe lines built recently have been designed to make use of a smaller amount of tankage for storage at the pine-line stations located along the trunk lines. This condition is especially true on the lines that are using motor-driven centrifugal pumps. This policy of carrying the larger amounts of storage at strategic points and only a small amount of tankage at the relay pumping stations indicates the present trend in the use of pipe-line tanks.

As a means of conserving the light vapors in petroleum, pipe-line companies are making use of the floating roof, especially at the pumping stations where the amount of petroleum handled through the pipe-line system is checked for volume. It is believed that where the floating roof is used at the relay stations on working tanks it should be used only on a tank with a smaller capacity than that of the 55,000-bbl. tank. The use of a 10,000-bbl. working tank would probably result in a smaller maintenance cost, less evaporation, and less trouble from water that might get into the tank. The point might be made that where the oil is not delivered into a large tank, say, a 55,000-bbl. one with a steel roof, serving only as a surge tank on the line, no large amount of evaporation occurs on account of the liquid in the tank standing at an almost constant level; but it is to be remembered that a rather large vapor space exists in the tank and that breathing will result with a change of temperature. Where the floating roof is not used it is common practice now on almost all tankage, except in West Texas, where the oil vapors are very corrosive, to use welded steel roofs which are vapor tight and are equipped with flame-proof venting equipment. In West Texas where corrosive oils are being handled, the wooden roof with insulated top, equipped with lightning protective equipment, is being used.

Some experimental work is being carried out in West Texas on the use of all-aluminum and part-aluminum tanks in sizes up to 1000 bbl. to eliminate the corrosion caused by the vapors from the oil produced in that region. The results which have been observed from the use of these tanks are said to be satisfactory.

Aluminum paint has been used extensively for painting steel oil tanks to reduce evaporation losses that occur in the storage of petroleum. A recent development has been the use of aluminum foil to coat the roofs of the tanks. It is claimed that the tests indicate that a great amount of heat is reflected from the tank, resulting in a much lower temperature in the vapor space and at the surface of the petroleum, thereby reducing the evaporation through breathing losses.

Corrosion of Pipe Lines

One of the largest maintenance costs in the operation of oil pipe lines is the repairs made necessary by the corrosion of pipe. These pipe lines operate at pressures as high as 800 lb. per sq. in. and consequently the corrosion of the walls affects the operating efficiency of the system. The American Petroleum Institute has undertaken a study of the corrosion problem, and considerable has been learned during the last two years as to its extent and as to some of the faults in the methods used in protecting the lines against corrosion. During the last three years much reconditioning of pipe lines has been carried out, and protective coatings have been applied to these lines. During the last year considerable doubt has been expressed among pipe-line men as to the effectiveness of these coatings, and it has become the policy of some companies to delay the reconditioning of pipe lines until material and methods providing for an effective coating have been found. The practice now of some of the companies is to recondition the lines where corrosive conditions are known to exist. The use of accurate records as to the failures in pipe lines due to corrosion is

assisting materially in locating the corrosive areas along the pipe line. In the meantime the corrosion committee of the American Petroleum Institute is obtaining some valuable information, which in time will be correlated and the question of protective coatings very much clarified. It is certain that if an effective protective coating can be found for the protection of pipe lines against soil corrosion, pipe with thinner walls and made of steel of high tensile strength will be used with confidence in the design of pipe lines, resulting in lower investment costs.

Economic Advantages of Joint Ownership in Constructing New Pipe Lines

About three years ago, two of the major oil companies built a long trunk pipe line under a provision of joint ownership. During the year 1929 two other major oil companies built a long trunk line under joint ownership. The advantages in such an arrangement are:

- *a* Risk reduced for each company.
- *b* Pipe line can be kept supplied with oil better than when owned by one company.
- *c* Use of one large line instead of two smaller lines with the same or smaller number of operating stations.
- *d* Materially reducing operating expenses by using one large-capacity system by two companies instead of two separate systems by two different companies.
- *e* Greater operating efficiencies can be obtained in one large system than in two smaller systems

From the engineering and economic viewpoint the joint ownership of newly constructed pipe lines has distinct advantages.

Pipe-Line Systems Affected by Economic Changes

An increasing amount of crude oil is being transported to the refineries on the Eastern Seaboard and Gulf Coast. The large amount of cheap oil that has been made available in Venezuela and in West Texas has resulted in the large amount transported by tanker. About five years ago most of the oil was being delivered from the Oklahoma and Kansas oil fields to the Eastern Seaboard refineries by pipe line. The development of the Venezuelan and West Texas crude oils has affected the business of the pipe lines crossing the state of Pennsylvania, and some of these have been sold for gas lines. West Texas crude oil is being delivered to Gulf ports, transported by tanker to the Atlantic Seaboard, and pumped by pipe line west as far as Franklin, Pennsylvania.

An extension of oil trunk lines has been made necessary by the policy of the major companies providing for nationally distributed products. This policy has resulted in the building of refineries in the principal market zones and the extension of the trunk pipe-line systems to these refineries.

The hydrogenation process used in the refining of petroleum may affect pipe-line transportation of petroleum, in that the increasing demand for gasoline can be supplied through the use of this process rather than through an increased crude-oil delivery.

When the hydrogenation process can be used economically for converting heavy oil into gasoline, it is possible that the heavy oils that cannot be transported economically will be refined near the source of production and the gasoline transported by pipe lines.

Although gasoline has been transported through pipe lines for distances as great as 100 miles, a new development has been the converting of an 8-in. oil line that has been idle into a gasoline line to transport gasoline from the Atlantic Seaboard into and across the state of Pennsylvania and into the Ohio Valley. This development is significant, because it may mean the beginning of gasoline transportation by pipe lines at a much lower transportation rate than the present tank-car transportation cost.

PROGRESS IN OIL REFINING[3]

Crude oil is coming into refineries both by pipe lines and tankers, the preferred way depending upon location of refineries and source of crude. The Eastern Seaboard refineries obtain most of their oil by tanker, and there has been a strong tendency to provide centrifugal pumps on the ships, usually electric-motor-driven, each pump handling about 1000 gal. per min. at 125 lb. pressure, this maximum pressure being limited by the strength of the unloading hose and the possibility of leakage at its wharf connections.

If tanks into which crude is being pumped are too far from the wharf, or where the unloading rate is very high, it is customary to install booster pumps on shore, of the multi-stage centrifugal type, motor-driven.

In either case, safety semi-automatic controls are provided by means of which pumping is stopped from either ship or dock by an ordinary fire-alarm pull box. Hydraulic automatic shut-off valves are also provided in the pumping lines, closing off the pipe lines in case of a break.

Tanks and Tank Roofs

Tankage for receiving crude oil in refineries is being made larger as the capacity of tankers is increased, and also depending on the size of the refinery. Eighty thousand barrels is becoming a standard refinery size, and in many cases the same size is used for gasoline storage. These tanks are still made of riveted construction, although on some smaller tanks electric-arc welding has been applied experimentally on bottoms. The roofs of the tanks are almost entirely electric-arc welded where no fire hazard exists, and many are trying some type of floating roof or a roof of similar construction, the main purpose being to keep oil in contact with the steel surface to avoid loss of light ends in the vapor space, or to prevent breathing within certain temperature ranges by holding the vapor space at pressures varying from several ounces to one pound per square inch.

Refining Stills

The development of stills is so rapid in many types that only a few of the outstanding features can be mentioned.

Fractionating stills, made up of tube heaters in combination with fractionating towers, commonly termed "bubble towers," are being built for a capacity of 10,000 and 12,000 bbl. per day, and units of 16,000 bbl. capacity are being planned.

Similar stills are being considered for the making of asphalt from heavy crudes, and the fractionating is done in two stages, using vacuum on the second stage. The use of vacuum materially increases the tower diameters, thereby involving not only very complex construction and arrangement, but also bringing up questions of maximum shipping dimensions which materially affect final construction costs.

Vacuum distillation is being rapidly developed on account of close fractionation and the larger production of valuable lubricating products, due to less loss resulting from overheating, which is apt to occur in the so-called atmospheric pipe still. Practically every refiner is interested in this process, and many have made trial installations. The initial cost and the size of apparatus have been the main drawbacks to rapid development heretofore.

As regards cracking stills, vapor-phase processes are gaining headway, in spite of high initial costs and difficulties with fixed as and coke formation, due largely to the anti- knock properties of the gasoline produced. While similar properties in cracking-still distillates are sought after in so-called liquid-phase cracking

[3] Prepared by Walter Samans.

stills, there is evidently real competition between different methods, and the development in each refinery will depend largely on the type of equipment already installed.

In cracking stills, the maximum temperature of 950 to 980 deg. fahr. in the outgoing oil, which may easily result in 1100 deg. on the hottest tubes, together with an outlet pressure of close to 1000 lb. has resulted in the application of chromium-nickel alloy tubes, at an initial cost many times that of the carbon-steel tubes, in all those portions of the tube heater subject to the higher temperatures.

Tube lengths of 30 ft. are quite common, and the established size of 4 in. O.D. × $^1/_2$ in. thick is being supplanted by even larger and heavier tubes, with possibilities of greater lengths as capacities are increased. At least one tube manufacturer is installing a drawbench for tubes 40 ft. long, the initial reason being that this length is required by the large-capacity fractionating stills where pressures may go only as high as 300 or 400 lb.

The object in all cracking stills is, of course, economical conversion of low-gravity fractions to a distillate that can be incorporated into a motor gasoline, and a satisfactory process requires that the fixed gas and corresponding quantity of coke be kept to a minimum.

Hydrogenation of Petroleum. By the introduction of hydrogen under pressures from 1400 to 4200 lb. and in the presence of a catalyst, it is now possible to convert practically all of the original oil into gasoline and other products. Carbon formation is actually eliminated and the production of fixed gases reduced to a minimum. Two plants which will employ this process are now being constructed by the Standard Oil Company of New Jersey at Bayway, N. J., and Baton Rouge, La.

PUMPS

Hot-Oil Charging Pumps. Charging pumps for stills, particularly cracking stills, are of interest to mechanical engineers from the viewpoint of high pressure and temperature and the need for corrosion-resisting metals. A reciprocating steam pump for a capacity of 6000 bbl. throughput of 600 deg. fahr. oil at 1400 to 1600 lb. discharge pressure, operating with crank and flywheel on the compound steam end, will use 20 lb. of steam per l. hp. with condensing operation, and cost in the neighborhood of $28,000, including foundation. Its floor space of 12 ft. × 32 ft. is its main drawback, particularly in the application to existing equipment. On the other hand, a ten-stage centrifugal pump for the same capacity, requiring a 400-hp. motor, will operate at 50 to 55 per cent efficiency, although guaranteed when new for several points above this figure, and will require a floor space of approximately 5 ft. × 14 ft., including motor; the cost, with foundation, will be in the neighborhood of $16,000.

The difference in economy between these two pumps would save the difference in cost in about two years' time, but the uncertain factor thus far is the maintenance expense and the damage that may be occasioned by small fires in the pump house.

Motor-Driven Pumps. Motor-driven reciprocating pumps with intermediate gears have been tried with satisfactory results, as they give very satisfactory operation, but must be of very rugged construction to avoid excessive wear on gears. The main objection to them, particularly the larger sizes, is that variable speed is not possible except with special motors for alternating-current or direct-current motors which may not be adapted to the current available, and in either case provide some additional fire hazard on account of sparks from the commutators.

Charging Multiple Stills. Charging pumps for cracking stills, as well as fractionating stills, have been applied to as many as twenty stills for one pump; however, it is then necessary to maintain the maximum pressure that any of the stills may require, this pressure being affected by friction losses due to carbon collecting in the tube heaters, in order to maintain flow control for each still. The centrifugal charging pump lends itself well to this service, particularly since the larger the pump the greater the efficiency, but this scheme has not been sufficiently used to lead to general adoption at this time.

Corrosion in Pumps. Corrosion in pumps is accelerated by reason of the high velocities through valve passages on reciprocating types and impellers on centrifugal types, requiring in the first instance stainless-steel plungers and valve parts, and in the second, chromium or nickel-chromium alloys. The initial cost and manufacturing losses on these materials add greatly to the final cost of the pump.

AUTOMATIC CONTROL OF STILLS

Full automatic control on stills has not been possible, due to imperfections in the apparatus offered and the severe requirements for service conditions, oils containing both finely divided solids, mostly carbon, and corrosive elements which cannot be eliminated economically.

Of course the usual pressure, speed, and temperature controls used in large boiler plants are applied to oil stills, and there are

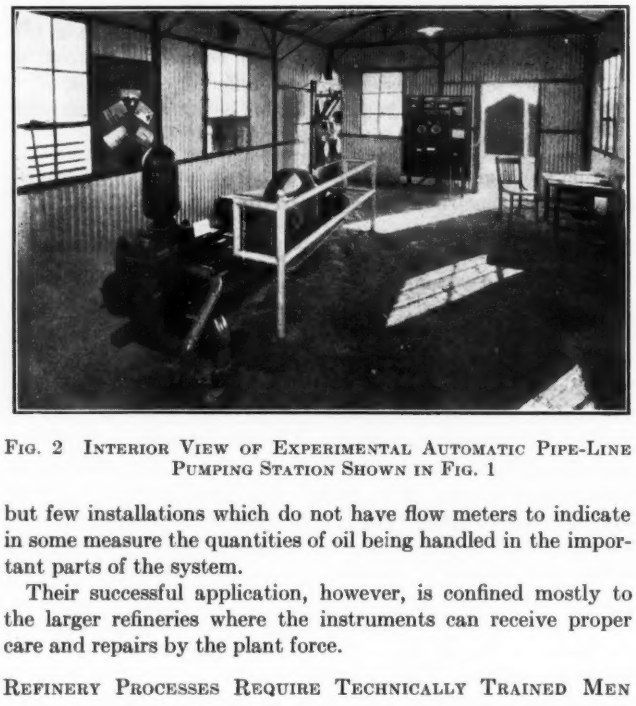


FIG. 2 INTERIOR VIEW OF EXPERIMENTAL AUTOMATIC PIPE-LINE PUMPING STATION SHOWN IN FIG. 1

but few installations which do not have flow meters to indicate in some measure the quantities of oil being handled in the important parts of the system.

Their successful application, however, is confined mostly to the larger refineries where the instruments can receive proper care and repairs by the plant force.

REFINERY PROCESSES REQUIRE TECHNICALLY TRAINED MEN

Just as in large boiler plants, it is found that technically trained men are required for the operation of important refinery processes, particularly still batteries, and for the proper supervision and maintenance of the equipment which is designed on high-grade technical principles. While chemical engineers are preferable in petroleum refining-process operations, the actual operating and maintenance work has been equally well handled by mechanical engineers.

GASOLINE RECOVERY AND STABILIZATION

In gasoline recovery and stabilization the maximum operating pressures are in the neighborhood of 300 lb. per sq. in., and while both compression and absorption plants, or a combination of these, are being used, depending upon local conditions, the greater initial cost of the absorption plant in connection with the recovery of gasoline from still gas is warranted by the greater percentage of recovery of the lighter hydrocarbons. There seems

to be no limit to the minimum quantity of gasoline per 1000 cu. ft. which can be economically recovered, this varying from three to fifteen gallons, depending upon the time of year and the temperature of the cooling water available, and of course the composition of the still gas.

General Practice

Treating Cracking Distillates. In the treating of cracking distillates, the tendency is very marked toward obtaining the maximum recovery of anti-knock fractions, which means the supplanting of acid treatment with processes similar to the Gray vapor-phase treatment.

Processing Lubricating and Paraffin Products. In the processing of lubricating and paraffin products, centrifuge dewaxing is making rapid strides, as all the more important refineries have such an installation.

Contact filtration is being used to a greater extent, but is limited to conditions where less than the highest-quality product is wanted.

Refrigeration is being used to remove waxes from lubricating oils and make them suitable for low-temperature operation, the oil being chilled to as low as —40 deg. fahr.

Drying of Fullers' Earth. In the drying of filtering clays, usually fullers' earth, the wedge furnace or one of similar design, consisting of a number of floors of refractory material over which the clay is moved by rotating arms counter to the flow of hot gases from a separate combustion chamber, has practically supplanted the old-type rotary kilns and various types of gravity furnaces. The expense of installing furnaces of the wedge type, however, has not permitted their general adoption by small refineries.

Acid Recovery. For sulphuric acid recovery plants, the vacuum system seems to be preferred in locations where occasional fumes from other types are apt to cause public nuisances, although, of course, the combination of acid concentrators with electric precipitators is still in use and being installed.

Multiple Heat-Transfer Units. Heat-transfer equipment for the larger still units is being mostly made in multiple-shell designs, although there is a tendency to standardize for convenience of stock and maintenance.

Corrosion of Equipment. Corrosion and deposits on tube surfaces are the main elements affecting the mechanical design, but there is a strong tendency in favor of making designed pressures much greater than working pressures, and large allowances for corrosion. Corrosion, particularly in gasoline condensers and exchangers, is most noticeable on initial condensation of the distillates, and chemical treatment of the charge is still applied as heretofore.

Piping. The adoption of the new American Engineering Standards for piping is becoming general, and for hot oil and vapors, seamless steel pipe has been generally adopted in place of lap-welded pipe.

Welding of the Lines. Welding of plant piping is coming into use where the pressure is not over 150 lb., but it is not yet thought feasible for hot-oil and vapor lines on account of the need for taking down lines for cleaning and for inspecting them for corrosion.

Power-Plant Practice

Steam boiler plants for refineries are being built for as high as 535 lb. pressure, with the needed superheat for turbine generators which may exhaust at sufficient pressure for process-steam distribution sometimes by the use of bleeder-type turbines; but, where possible, the plant is designed to balance the power requirement with process steam.

Steam is further superheated for process work, varying from 800 deg. fahr. total temperature at 10 lb. pressure, to 500 deg. at 120 lb. pressure.

It is still the practice for each refinery to generate its own electric power on account of this need for process steam, but in some special cases power has been purchased on account of remoteness of power use, compared to the location of steam plant, or some particular advantage in the cost of purchased power.

In the application of power, the possibility of gaseous atmosphere around pumps handling petroleum and its products makes it customary to place a fire wall between the motor and pump, surrounding the shaft by a stuffing box.

In some cases, particularly on foamite and water pumps, dual drive is applied with a motor at one end and a steam turbine or gasoline engine at the other. These run in sizes from 150 to 300 hp.

While a brush-shifting-type motor has been used in a few instances for a variable speed on reciprocating power pumps supplied with reduction gears, usually of the herringbone type, they have not gained much favor, because of first cost and the possibility of sparking commutators' igniting gas, even though the motor be in a separate room.

Progress in Steam-Power Engineering

Contributed by the Power Division

Executive Committee: F. M. Gibson, *Chairman,* Alfred Iddles, *Secretary,* V. E. Alden, V. M. Frost, and W. F. Ryan

The developments in 1929 have followed the trend of 1928, and a continuance through 1930 is probable. The year has witnessed larger mergers of invested capital, larger interconnections of central stations, larger industrial heating loads as well as larger power loads diverted to central stations, larger stations, larger equipment units, and larger demands for electrical power. The single word that is most descriptive of this advance is "magnitude." Improvement has been made in more clearly defined fields of application of types of equipment rather than in any radical change in design. So great is the number of possible combinations of types of equipment that can be made to meet the singular conditions of the individual station, that the employment of a particular type of equipment in the design of a new station is not necessarily indicative of the general trend of practice.

Recent and anticipated mergers of large power corporations presage a hastening of the interconnection of major distributing systems, thereby making possible greater modern stations with larger equipment units, the reduction of investment in stand-by equipment, the more effective use of water power, and increased research, all of which tends toward a lower cost of production with a consequent increased demand for power.

Developments in Boiler-Plant Equipment

The most outstanding developments in boiler-plant equipment are the rapidly increasing capacity and continuity of service of steam-generating units. Within the current year there will be placed in service several such units, each having a maximum capacity of nearly one million pounds of steam per hour. One plant, equipped with water-cooled walls and pulverized-fuel firing, operated eight months with no outage at time of demand. The effect of water-cooled walls upon the elimination of outages by means of their reduction of repairs to furnaces and combustion equipment, together with their quicker cooling at times of repairs, has led to their almost universal application in larger installations and their more general use in smaller units. There are now available individual steam-generating units capable of operating a turbine of over 80,000 kw. capacity and having a reliability nearly equal to that of turbo-generators. This fact will probably have considerable influence upon the design of future power plants.

In stations with a high load factor there has been an increase in the number of plants designed for steam pressures of approximately 1400 lb. In the design of these plants there has been a decided tendency toward straight-tube, cross-drum boilers, although the more recent and improved design of bent-tube boilers may alter this trend. The advantage of limiting hot-metal spots in superheaters has evidently been sought in boilers and water-cooled furnace walls, resulting in a reduction of heat transfer per square foot in order to reduce maximum metal temperatures. A few stations of moderate load factors have been designed for 650 lb. steam pressure, while nearly all new stations of low load factor are designed for pressures of about 450 lb.

There has been no trend toward higher steam temperatures except for experimental purposes, and though designers have preferred greater reliability and less efficiency at 750 deg. fahr. (and probably will until less expensive materials are available), there are positive indications that higher temperatures will be used in the near future. Two installations for use in this country have been purchased for steam temperatures above 800 deg. fahr., and actual experience with these temperatures should be available soon. In one comparatively new station, interdeck superheaters with plain steel tubes have been operating at a steam temperature of 780 deg. fahr., and this temperature will be increased gradually to a point in excess of 800 deg. or until signs of distress develop. Experiments are being made on an oil-fired superheater of a capacity of 6000 lb. of steam per hour at steam temperatures of from 700 to 1100 deg. fahr. for the purpose of determining the effect of high temperatures upon superheater tubes, valves, piping, and fittings. Manufacturers are prepared to build superheaters, turbines, and piping for steam temperatures of 800 deg. fahr. Other trends in superheater design that will assist in promoting higher temperatures are in the direction of increasing the velocity of steam through the elements, reducing it through the inlet and outlet headers, thus insuring proper distribution of steam between elements, and in providing greater protection of the superheater with an intervening bank of boiler tubes.

With a steam temperature of 750 deg. fahr. practically all stations designed for pressures over 450 lb. are reheating the steam. Of two stations designed for a steam pressure of 650 lb. at 750 deg. fahr., one does not employ reheating while the other reheats to a temperature of 500 deg. In plants of steam pressures higher than 650 lb. the steam is universally reheated to the original temperature of the steam. Single-stage reheating has been used in all of these stations with the exception of two now under construction. In these two stations there is a combination of a steam reheater with a gas reheater. The temperature of the reheat is maintained nearly constant by thermostatically controlling the temperature of the steam from the steam reheater by the temperature of the steam leaving the gas reheater.

In high-steam-pressure stations the total heating surface of air preheaters, reheaters, bleeder heaters, water-cooled furnace walls, and economizers has increased until the actual boiler heating surface is only 12 per cent of the steam-generating-unit heating surface, and only 0.3 sq. ft. of boiler heating surface per kilowatt of plant capacity. Under these conditions the terms "boiler rating" and "boiler horsepower" have little or no significance.

Trend in Fuel Firing—Feedwater Heating

The trend in fuel firing in recently designed or constructed large stations is decidedly toward pulverized fuel. In the central stations the bin system seems to predominate, while in the industrial field the unit system is favored. Pulverizing mills with a capacity of 25 tons per hour are now in operation, and one station with larger boiler units is using as many as five mills per boiler. The largest steam-generating unit soon to be placed in operation is designed for pulverized fuel with the unit system. The rate of combustion in recently designed pulverized-fuel furnaces of large size range from 18,000 to 30,000 B.t.u. per cu. ft. of furnace volume. Several slag-tap furnaces are in operation with a combustion rate of 42,000 B.t.u. Although this type of furnace requires a minimum fusion temperature of ash of 2500 deg. fahr., it may be of special advantage where the disposal of fine ash from the furnace is a problem. There is as yet no completely satisfactory method for the removal of ash carried up the stack.

While the trend has been toward pulverized fuel and there seems to be no limit to the capacity of the pulverized-fuel-fired furnace, the progress of the underfeed stoker is impressive. Nearly every month of the present year has established a record in the number of retorts sold, that for August being 1900 retorts. There are now available individual stoker units capable of producing 500,000 lb. of steam per hour, each which with double-end firing makes possible the output of 1,000,000 lb. per hour from a single stoker-fired boiler. One manufacturer has produced a ram capable of feeding 40 lb. of coal per stroke. Experiences of the past year indicate that a gradual and complete redesign is taking place. The development has not been confined to any one part, but the most noteworthy improvement has been in the handling of the fuel bed. This has been accomplished by reduction of wind-box air pressures and better methods of conditioning to provide a light and spongy fuel bed.

There has been no outstanding change in the design or application of air preheaters. Accurate test and operating data are now available for determining design. Gas spacing has been determined for different fuels, and means provided to maintain this space free from slag or ash. Better provision has been made for expansion to prevent warpage of elements, and considerable attention has been given to the sealing against air infiltration.

Feedwater heating shows an apparent trend toward the more effective use of the regenerative cycle. Four-stage heating is quite common, and in one station the feedwater will be heated in five stages. Increase in steam pressure justifies an increase in the temperature of feedwater by means of bled steam. This is evidenced by the heating of feedwater to a temperature of 430 deg. fahr. in a station recently designed for a steam pressure of 1400 lb.

Never in the history of the profession has feedwater treatment been given as much attention, both in research and in practice, as in the past year. One significant trend is the practice of combining processes. Combinations of chemical and zeolite softening, addition of coagulants with softening reagents, the continuous blowdown system, and steam purifiers have brought a change in feedwater treatment and provided the designing engineer with a greater number of methods from which he can choose to treat a specific condition. Although research is still being made to determine the process by which electrolytic methods prevent corrosion,

several successful installations have recently been made. There has been a decided increase in the use of sodium aluminate and phosphates.

Several instances of severe embrittlement in boiler steel have occurred during the year, and it has been found in highly stressed areas, in expanded as well as riveted joints. When the ratio of sodium carbonate alkalinity to sodium sulphate was established by the Boiler Code Committee, there were not sufficient operating data to warrant carrying the ratio above 250 lb. pressure. Later sufficient data were developed to warrant extending the ratio to 600 lb. pressure, the ratio increasing in proportion to the increase in pressure as indicated in the ratios for lower pressures. When the ratio is applied to higher pressures, the amount of treatment becomes excessive. Laboratory investigation indicated phosphates as a desirable inhibitor of embrittlement. Many stations began the use of di- and tri-sodium phosphates and, more recently, mono-phosphate. There have been no known ill effects to date, but the use of phosphates has not been practiced for a sufficient length of time to positively substantiate laboratory results.

Larger Turbine Installations

The growth of power systems has made larger turbine installations economically possible. During the past year several noteworthy installations have been completed, and orders have been placed for others of unusual interest. All of the larger installations are of special designs built to suit special conditions to fit in with the power systems and the economic policies of the power corporations. There are also quite a number of installations using simple turbines of a more standard design. In one instance a public-utility corporation has installed eight duplicate units with machine tolerances limited so that all parts of the machines are directly interchangeable. The largest single generator unit, 60 cycles, 1800 r.p.m., now on order is a 115,000-kw. and the largest system of units with three generators, 60 cycles, 1800 r.p.m., in operation is for 208,000 kw. One outstanding installation is a tandem compound turbine with a single generator having a double winding with a capacity of 160,000 kw. An interesting development of the year has been the purchase of three steeple compound units. An indication of another possible development is the recent construction of a small turbine with a welded steel-plate casing.

Recently designed stations indicate a decided increase in the use of single-pass condensers. The amount of condenser surface per kilowatt of turbine capacity shows a downward trend. Several stations have been designed for 0.8 sq. ft. and one station for 0.575 sq. ft. of condenser surface per kilowatt of turbine capacity. One outstanding development of the past year has been the general use of condensers with tubes rolled in at both ends and methods for taking care of the expansion of tubes and shell. There are four methods of accomplishing this, but no positive indications exist which forecast the method of the future. Another outstanding development has been the installation of a welded steel-plate condenser. This unit, of 27,000 sq. ft. of condenser surface, serving a 30,000-kw. turbo-generator, was designed, constructed, and placed in service in five months at a cost considerably lower than any quoted on a cast-iron condenser. The performance of this unit shows the air leakage to be very low.

Installations with steam pressures up to 1200 lb. with a temperature of 750 deg. fahr. are common, and stations with a steam temperature of 850 deg. fahr. are being constructed. Experiments with a temperature of 1000 deg. fahr. are being made. A 10,000-kw. turbine is being constructed abroad for installation in a central station in the United States for operation at 365 lb. inlet pressure, an exhaust pressure (absolute) of 1 in. of mercury and an initial temperature of 1000 deg. fahr. This unit is for experimental purposes to determine the behavior of the metal in the turbine, and especially of valves and joints, at high temperatures under operating conditions.

Industrial Steam Power

Industrial power constitutes only a small portion of the total power generated in the country, and the fuel consumed by industrial boiler plants, exclusive of railroad and gas plants, is several times that used by central stations. This condition illustrates the comparative importance of the generation and utilization of power with that of heat in the industrial field. The increased use of steam-flow meters has resulted in greater efforts to improve the efficiency in the utilization of heat. This has constantly reduced the heating load, while the installation of automatic machinery and materials-handling equipment has increased the power load. For this reason the balance of steam systems is destroyed in many plants. During the past year there have been a number of complete boiler and power plants installed as part of extension or modernization programs, but the greater part of recently installed equipment has been for the purpose of restoring the balance of steam systems. This has been the situation in textile, food, chemical, and paper plants, particularly in the latter. Advantages have been taken of higher steam pressures and high-back-pressure and extraction types of turbine delivering steam to process or to the original boiler-steam mains. There has also been a decided increase in substituting high-back-pressure turbines for motors in power-plant auxiliary drives as well as in service-equipment drives. The increased use of refrigeration has been of considerable help in maintaining steam balances. When extraction turbines are used, particularly in the paper and textile plants, the bled steam is sometimes superheated to a temperature injurious to materials in process and desuperheaters have to be used.

Exchange of power between central stations and industrial plants is gaining in favor, and a number of plants report that it is working to the advantage of both parties. Also, in several instances, central stations have built plants to supply both steam for process and power to one or a number of industrial plants in the vicinity. In such cases non-condensing high-back-pressure turbines are employed, exhausting to the process-steam mains and floating on the line, electrically in parallel with the system; the electrical load supplied by them being governed by the process-steam demand.

Several manufacturers of pulverized-coal equipment report greatly increased sales of unit pulverizers to industrial plants, but pulverized coal has not had the field to itself for stokers have been installed in a great many of the new or remodeled plants. In several cities where smoke-abatement activities prevail, the smaller stokers have found a ready market in the smaller industrial plants.

More attention is also being given to the better utilization of waste heat either in boilers or in air preheaters. About one-third of the newer plants use air preheaters, and a somewhat smaller number employ economizers.

Much greater attention is being given to feedwater treatment, and technical supervision is more generally employed. The trend in methods used is similar to that in central-station practice. In some instances evaporators have been installed to take a considerable portion of the boiler steam, returning the condensate to the feed lines and delivering pure vapor to process.

In conclusion, it may be stated that the present status of research, design, and performance forecasts an even greater progress in 1930.

Grateful acknowledgment is here made to the many engineers whose assistance has made this report possible.

F. M. Gibson, *Chairman.*

Progress in the Printing Industries

Contributed by the Printing Industries Division

Executive Committee: Edward Pierce Hulse, *Chairman*, Harold E. Vehslage, *Secretary*, Winfield S. Huson, John Clyde Oswald, Frederick M. Feiker, and George C. Van Vechten

THE Printing Industries Division, in presenting the report for 1929 through the chairman of the Progress Report Committee, Mr.. Winfield S. Huson, feels that it is somewhat of a coincidence that the first development chronicled should be a continuation to so marked a degree of the 1928 report; for the teletypesetter is the latest development in the field of setting type by mechanical means. As its final application is to the keyboard of slug type-casting machines, and as electricity plays a prominent part in the operation, it will be noticed that it not only extends the usefulness of the casting machine but, too, amplifies the means by which news may be transmitted quickly from a central point to others more or less remote; and as news is one of the vital needs of today, the teletypesetter cannot help but be of interest in its parts and method of manipulation. It really is a combination of units by means of which the typesetting machines set the type or matrices by

FIG. 1 TELETYPESETTER, SHOWING THE SENDING MACHINES, TELETYPE CORPORATION, CHICAGO, ILL.

telegraph, and the development was made possible by the recent great advances in the technique of telegraphic communication. Briefly, the sequence of operations is, first, a perforator which punches a paper tape $^7/_8$ in. wide with subject-matter to be ultimately set in type, the perforations being in code. The tape then passes through a transmitting distributor, which translates the code into electrical impulses, which may be carried over telegraph wires to long distances, as one transmitting distributor can send out impulses which may be received simultaneously by any number of stations. In connection with the perforator, a teletype will print by impulse from the tape, whereby the operator can see and check a typewritten copy of the message being sent.

Fig. 1 gives a very good idea of the sending means. It will be understood that the perforations constitute electrical impulses of varying intensities which are transmitted over the wires and which act upon a receiving perforator which punches a tape corresponding with the original tape and also gives a typewritten copy enabling an operator to edit the matter as it is received.

The group of machines in Fig. 2 shows the installation connected with the keyboard of the type-casting machine. The punched tape passes from the receiving perforator to a transmitting distributor which retranslates the message into electrical impulses and automatically decodes it. The final mechanism then operates the key reeds controlling the type matrices, and the casting of the lines of type automatically proceeds the same as when the machine is operated by hand. There is no

FIG. 2 TELETYPESETTER, SHOWING DECODING AND OPERATING MECHANISM, TELETYPE CORPORATION, CHICAGO, ILL.

material alteration required from the original form of a hand-operated machine, and the application of the teletypesetter is very simple.

There is of course much detail that cannot be gone into at this time; nevertheless, it is an example of the trend of the inventive mind to eliminate still more the need for manual operation in the ordinary sense, as well as also effecting the great saving of time that results in the transmission of matter to various points.

Here, too, enters a thought regarding the transmission of pictures by radio and their quick conversion into printing plates for the press; for as the pictures are received, the skill of the photoengraver and the electrotyper is called into service, and pictures of current events may be electrically transmitted and then printed the world over.

Then, too, there is the present-day sending of telephotographs in which it is possible to telegraph a photograph, an illustration, or anything that can be photographed, and have it reproduced with fidelity in a very brief time, or at least as fast as a telegram, whether the distance be short or thousands of miles away.

Thus we find the mechanics of material things effectually bonded to ethereal phenomena in a pictorial form which everybody can comprehend.

How quickly we move will find an illustration in the teletype-

setter; and also today there are going on experiments having for their ultimate development the composing of matter by photographic means, the end in view being the use of duplicate films from which printing can be very rapidly done. This, if brought to successful fruition, will compel very radical modifications in our present machinery and in all probability involve color work in speedier and more beautiful production. So in the printing industries, as in everything else, there is always something more to be done; and invention, development, and application are ever present in opportunities for the laboratory and the engineer.

In the foregoing we have spoken of means for quickly producing type and pictures necessary for the dissemination of news. There is, however, one other very necessary factor, and that is paper; and while it is not the intention to deal here with its manufacture, the improvement made in the machinery for winding rolls of paper is worthy of mention. In the modern high-speed rotary presses, their potential speed cannot be fully reached because of the limitation imposed by uneven or unbalanced rolls of paper, which are so conducive to broken webs. The great

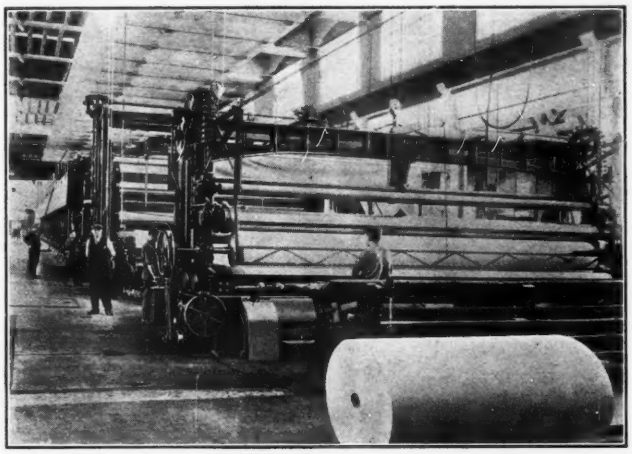


FIG. 3 ROLL WINDER AND SLITTER, CAMERON MACHINE COMPANY, BROOKLYN, N. Y.

consumption of paper and the necessary high-speed production have compelled development in winding machinery which only a few years ago was considered unnecessary; but the developments in paper-making machinery and in calendering machines, such as referred to in last year's report, have made it necessary to have winders that will produce true rolls of paper.

In Fig. 3 is shown a roll winder and slitter for newsprint made in very wide webs which are slit and wound into several units of required press widths as shown in the foreground of the picture; and here again, while space does not permit detail, these winding and slitting machines have been developed to a high state of perfection and operation. The endeavor has been to meet such comment as that of the head of the mechanical department of a large metropolitan daily, who said: "If by a perfect roll you mean one that is perfectly round, straight, and even on the ends, and equally firm and held throughout the run, then we shall have one that will unwind at top speed without jump, vibration, or web break." In the picture there also is an opportunity afforded for judging of the great amount of room required in just one item of the machinery of the Printing Industry. The web of paper in this case is about 266 in. wide, and the length of room required can be judged by the length of the paper-making machine in the far background, then the paper-calendering machine, and finally in front, the winder; for these units are operating really as one, and as the production speed is high, in the neighborhood of 1000 ft. of paper per minute, some idea may be had as to what engineering in paper mills means, not only from the structural standpoint but also from that of foundations and, by inference, of materials handling.

There is a feature in connection with the manufacture of paper that also enters into printing, and that is air conditioning, in which marked advances have been made. There is now no question that air humidification and air control are becoming more and more necessary adjuncts to the printing industry in all its ramifications, and from simple beginnings this feature has grown into a real engineering activity, not only because of its value in providing clean, healthful air within a factory, but,

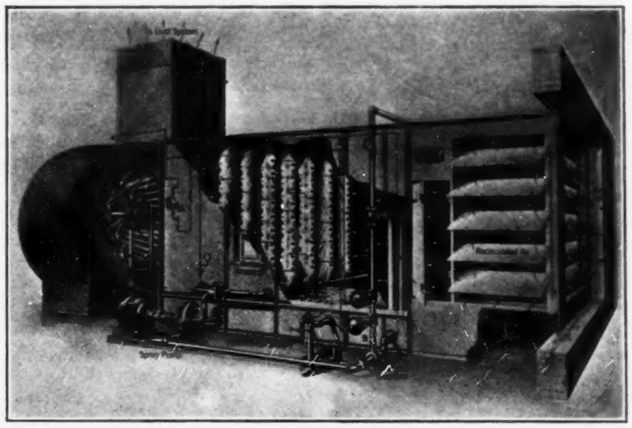


FIG. 4 TYPICAL CENTRAL-STATION HUMIDIFIER AND AIR WASHER, CARRIER ENGINEERING CORPORATION, NEWARK, N. J.

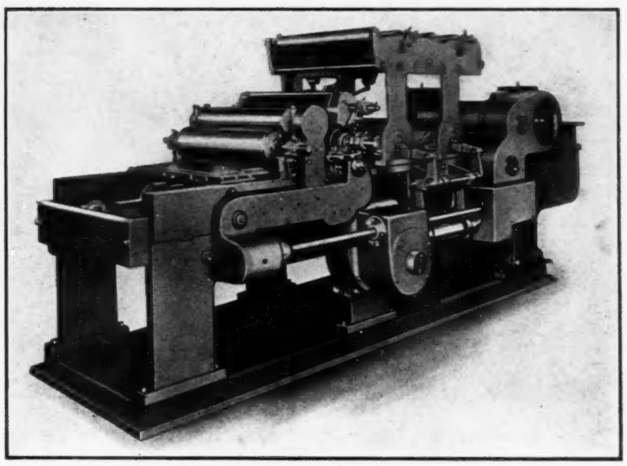


FIG. 5 STEEL-PLATE POWER PRESS, R. HOE & CO., INC., NEW YORK, N. Y.

too, because it certainly is becoming more and more necessary in preserving uniformity in the moisture content and other features of the paper, particularly in color work, where the uniformity of air conditioning and the ability to control it in degree have made for better working conditions and better output.

From the standpoint of printing, a quotation from Mr. J. Horace McFarland[1] would not be out of place and undoubtedly would pertain to other plants where air-conditioning apparatus is installed. It may be said that a recent installation has been placed in one of our large Midwestern newspaper plants, to the

[1] President, Mount Pleasant Press, Harrisburg, Pa. Member Research and Survey Committee, A.S.M.E. Printing Industries Division.

better service in every way of men and machinery. Quoting from Mr. MacFarland:

"From the human standpoint, experience seems to show that if air conditioning could be included in the primary provision for any particular plant, it would be advisable by reason of the greater comfort and consequent better morale it provides. Pressroom workers have told me that they do not have the late-afternoon fatigue, and we estimate an increased production due to air conditioning a very definite amount, quite justifying the expenditure.

"The other standpoint of consequence relates to precision in work in color printing. It happens that the business I direct depends on accuracy for its prosperity, and that variation in shades used on a woman's face in modern color printing which is accepted as a delivery of good color printing would be utterly impossible when the subject is a tomato or a rose, a bunch of grapes, or a spike of delphiniums. Our customers sell by color, and form and accuracy are essential. It is indeed this success of sales effort that we are selling to our customers rather that mere printing.

"So uniformity of condition in which various colors are superimposed is quite essential. We got along for many years by allowing for abnormal spoilage due to variation in register and by actually waiting while the humidity fluctuated to what we needed to complete the work. Under this latter rule in one season we added something like 1500 press hours, which, at an average cost of $3.55 per press hour, was an expensive matter, independent of the loss of productive time.

"Now, under complete and orderly air conditioning, involving dehumidification as well as humidification, we lose none of this time. Our spoilage allowance is decreased and the work is improved in quality throughout.

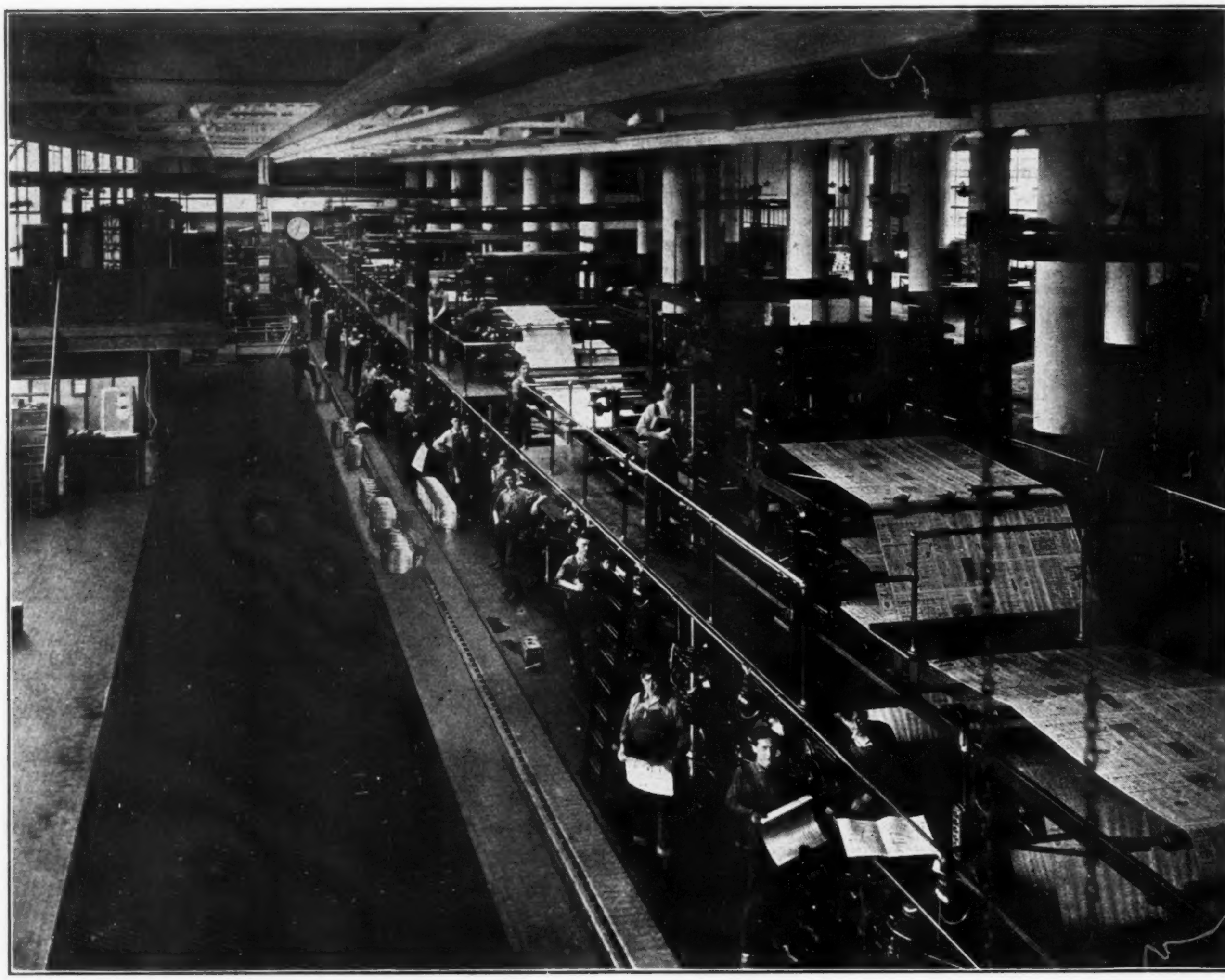


Fig. 5 Newspaper Rotary Printing Press Installed in Plant of Cleveland "News" by R. Hoe & Co., New York, N. Y.

"It is, I think, a significant advance in printing engineering that attention should now be paid to air conditioning, but it is likewise a misfortune that so much gross ignorance is being manifested as to what air conditioning is.

"As I see it, printing as the basis and support of all modern and industrial progress needs continually better engineering, and it is the engineering manifested in air conditioning that I now most heartily commend."

Fig. 4 gives an idea of the extent of apparatus for conditioning air, the incoming air being thoroughly washed and passed through an eliminator, caught by a circularizing fan, and sent through the duct system to various parts of a plant. There is also applicable to the system the means for withdrawing the air and supplying fresh air at stated intervals, and for installing recording instruments which give the exact condition of the air in a room, so that the whole is under constant control.

There is also another important gain in air-conditioned press-rooms. A great deal of dust, which always has been a source of annoyance in fine printing, is drawn out, while the incoming air is kept as free from dust as it is possible to have it.

One form of printing which, because of the advance of photography and advances in the art, has been pushed aside is that of steel-plate engraving. There are comparatively few examples of it in modern printing; still there can be no less of admiration for the skill and beauty of some of our old-time steel engravings, even if later methods have also produced beautiful pictures. However, plate engraving is not dead. In fact, let us hope there may be a renaissance of this beautiful work.

A new steel-plate power press has been brought out, and its construction has been carried to a high degree of perfection, not only in its mechanism, but also in the character of the work done and the elimination of much of the manual hand labor that pertains to the old method of producing these prints.

Fig. 5 is an illustration of a power plate press taking plates up to 22 in. by 31 in. In this press the plate, which of course has the design in intaglio, is inked over its entire face; then the plate is mechanically wiped free of excess ink and polished, thus leaving the ink in the depressed portions only. The sheet to be printed is taken by an impression cylinder, and the plate passing under the sheet leaves its design upon it.

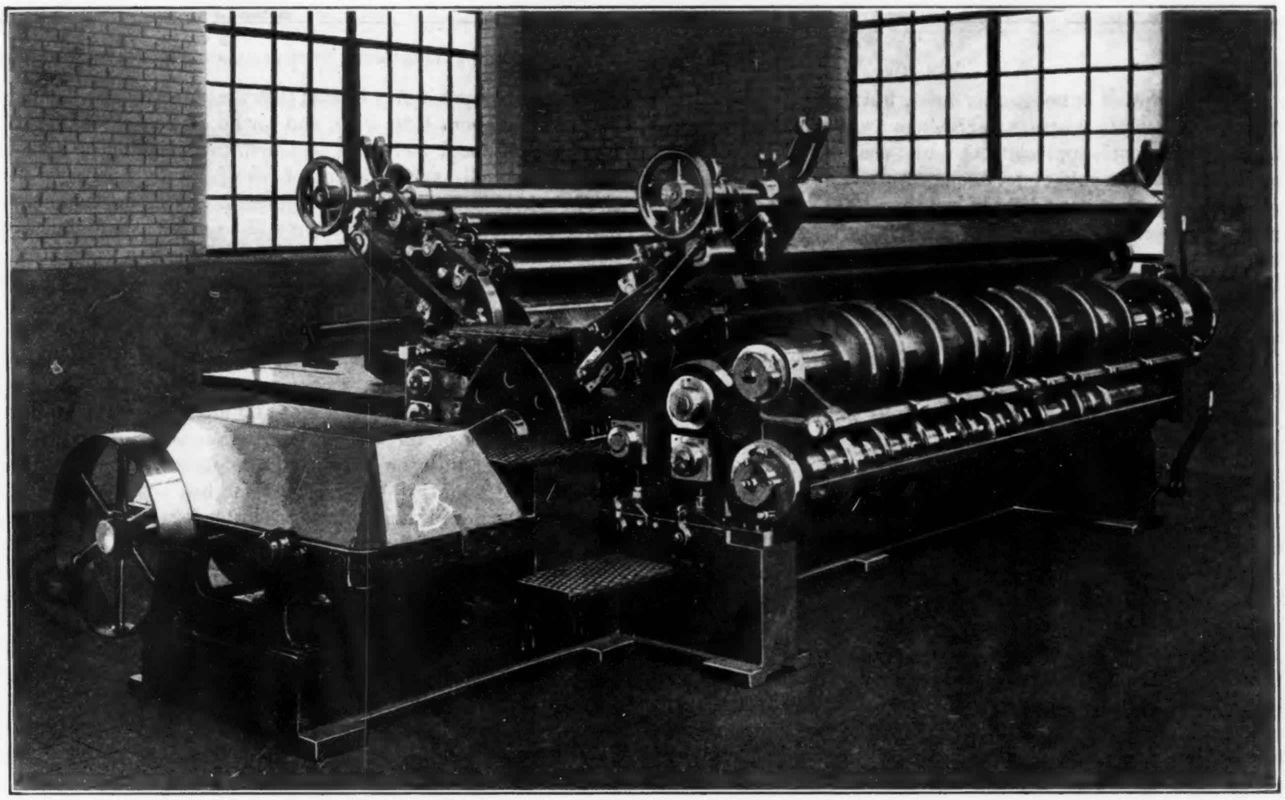


Fig. 7 Two-Color Boxboard Printer and Slotter, Samuel M. Langston Company, Camden, N. J.

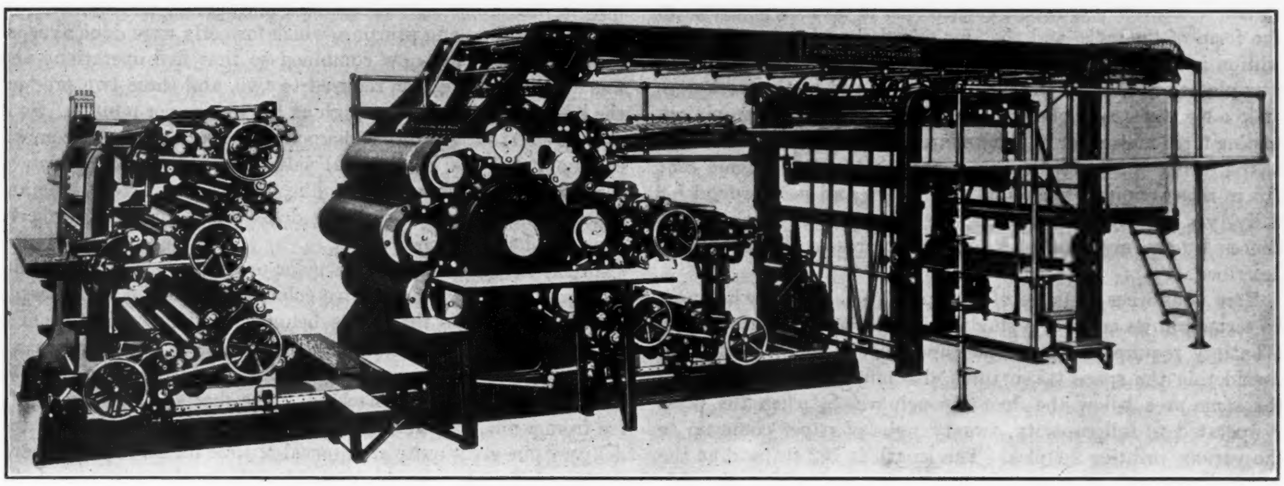


Fig. 8 Five-Color Printing Press, Claybourn Process Corporation, Milwaukee, Wis.

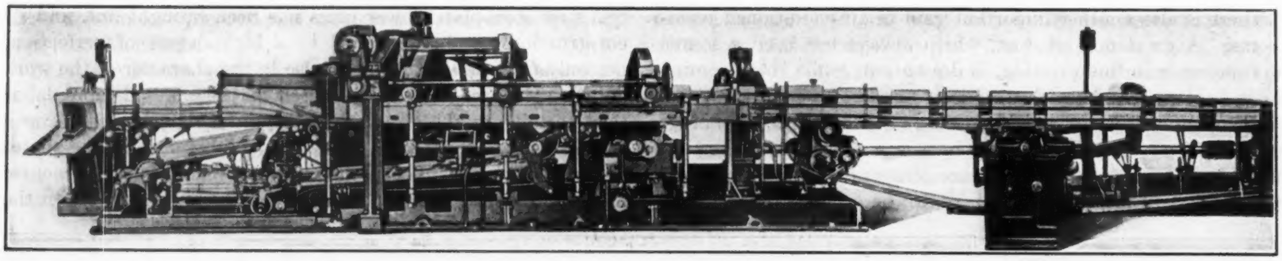


FIG. 9 GATHERING, STITCHING, AND COVERING MACHINE.

This description is necessarily brief, but one who knows how laboriously early steel-plate engravings were produced, entirely by handwork, will appreciate the advance made in this power press which is capable of producing upward of 500 impressions per hour as against considerably less than 100 by the old presses, many of which are still in use. No plates for the printing of banknotes, certificates, and the like quite equal the beauty of the engraved picture. Let us hope that the skill of the old hand engraver on steel plates will not pass out as has taken place with wood engraving.

There is a feature about this press that is worthy of mention as applying to operative machinery in general, and that is the care that is taken to guard as fully as possible the moving parts, as so well shown in the picture.

In last year's report mention was made of the remarkable improvement in the newspaper rotary printing press, and within the year there have been marked advances. Fig. 6 illustrates a recent installation for a Midwestern daily paper with an hourly capacity of 400,000 printed and folded newspapers up to 16 pages, 200,000 from 18 to 32 pages, or 100,000 from 36 to 64 pages. The press is equipped with every known device of modern practice that can be utilized to reduce time and increase production. It is composed of twenty distinct printing sections or units and five "superspeed" double folders. The units are in line, and each printing unit is composed of two plate and two impression cylinders, a plate cylinder carrying eight stereotype plates each the size of a page. As there are two cylinders to a unit, 320 plates are required to completely cover the twenty units. As a single plate weighs about 70 lb., the entire press carries a total of more than eleven tons of stereotype metal in the form of "news"—and that for one daily edition. After an edition is finally run off, the plates are removed, remelted, and new plates are cast for the next edition. And so the work goes on in a big newspaper plant; never at rest, busy molding opinion, casting forth matter for public welfare and guidance, then merged at the furnace of experience into newer material and again sent out in never-ending streams of intelligence and mental food for daily, yes, hourly consumption, the demand for which is evidenced by the need for such mammoth presses as here briefly described.

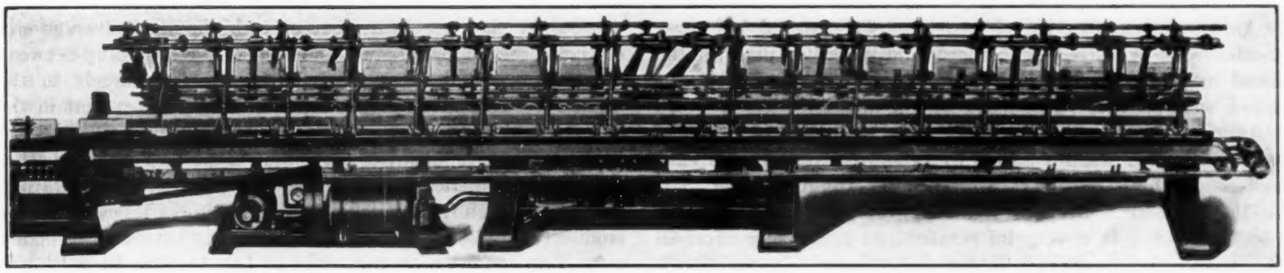
Here is another instance of the space required for what may be termed in its entirety a single unit, and which is only one of a battery required for some metropolitan dailies of today. In considering the space taken there also must be included about the same area below the floor through which, when the press is operated to full capacity, twenty webs of paper come up to the various printing couples. The length is 192 ft., and as the width of the web of paper is about 6 ft., and within the side frames of the press, when the space taken by machinery and passages is considered, 30 ft. would seem to be a minimum required width. The weight is about 450 tons, and withal the press is very accessible in its parts; in fact, it must be, for all moves have to be expeditious. Newspaper men know too well what a delayed edition means, and that it must not happen.

As incidental items it may be said that the paper rolls are 32 in. in diameter by about 6 ft. wide, and for an edition of 400,000 16-page papers about 300 miles of newsprint weighing 50 tons is required as well as 170 gallons of ink.

The whole equipment is quite illuminating as an instance of materials handling. This picture will to some extent illustrate how advantageous it is, now that air-conditioning apparatus is so dependable, to have it installed in newspaper pressrooms for keeping ink, paper, and men in good condition.

A quite common question is, "What becomes of the great mass of used newspapers?" The answer, to a large extent, is found in the paper box containers now so familiar to us. The card stock is made from waste newsprint and formed into large sheets, and in the case of three-ply corrugated board, the sheets are pasted together with the corrugated sheet usually in between, and then printed, punched, and scored for box purposes. Fig. 7 shows a two-color printing press and slotter for this class of work, the slotting disks being well shown in the foreground. We have been so accustomed to thinking of printing plates as of hard material that it is worth noting that boxboard is printed from rubber type tacked to cylinders having wooden lagging. This may seem a rather primitive way of securing plates and getting register, still it fits in admirably for this class of work, as will be readily understood by pressmen who, in their endeavor to get color register, often wish their plates could be rubber too. In the picture the space between the inking mechanism shows how readily plates can be fastened to the cylinder, as well as the general convenience of the machine. In this case, both colors are printed on one side of the card stock, which is fed from a roll. The press is only one unit in the whole operation, the sequences of cutting, slitting, slotting, scoring, and printing, which formerly were done as separate operations, are now combined so that five operations and five handlings have been reduced to two, and these two produce the boards at a speed of as high as 150 blanks per minute. So it may be said that what we look upon as newsprint waste becomes a commodity of real commercial value and utility in the form of cardboard containers and the like, and to this extent it is another example of what is being done with a material formerly considered as industrial waste.

In the magazine field a new color press has been brought out. This press will print up to five colors on a sheet at one passage through the press, the sheets being flat-fed instead of from a roll. The press will take various-size sheets up to its maximum size of $46^1/_4$ in. by 71 in. This would therefore seem to make it a very versatile machine. The sheets are automatically fed from a pile, and the length of run between final color and the delivery pile gives quite an interval of time for some preliminary drying of the ink. In this press there is another instance of the resort to modern construction, materials, and precision workmanship. Ball and roller bearings are used wherever possible; so also is an automatic oiling system, operating under pressure. The accurately ground cylinders are an instance of what printing-machinery engineers are doing to meet the ever-increasing demand for fine color work, as for instance as shown in Fig. 8.



AMERICAN ASSEMBLING MACHINE CO., INC., NEW YORK, N. Y.

The speed of this press is 3000 sheets per hour, which, with five colors, would be the equivalent of 15,000 sheets on a single-color press.

It would not be out of place to say here that probably in no other class of machinery other than printing is there more ingenuity displayed in the utilization of accurate mechanical movements, for in a five-color press there would be much loss if there was a failure of colors to register and print properly at so high a production rate.

A comment by one of our prominent printers is worthy of mention at this time. Regarding a tendency to revert to smaller presses, he says: "While bigger and better presses will always be in demand, there is, in the field of usual printing, a distinct trend toward the increased use of smaller high-speed presses. There are several reasons. Smaller sizes of printed matter are in vogue. Orders are for smaller quantities than formerly. In other words, it is the same story as of last year, of hand-to-mouth buying and of quick service which small presses can quickly furnish, as well as of the mechanical perfection of the small high-speed press in which modern design has made possible higher speed with least machine wear. There are automatic feeders that are fast and positive and that insure operation at full capacity; and there also is the fact that the time on small presses is but a fraction of that required for larger units, and also that one pressman can operate two or more of these small presses, so that this flexibility of equipment tends to outweigh the advantages of multiple layouts for larger machines except in the case of very long runs."

The idea of having this in the report at this time is that the same thought seems to be obtaining in the machine-tool field regarding the highly organized machines in which there is a question as to the ultimate economy of trying to do so much within one unit, which could be fully as cheaply done under separate operations, particularly where if anything happened, say, in the sequence of operation in an automatic, the entire tool would be held up. So one can see that in printing there are conditions similar to those in other familiar lines.

There is one line of machinery which enters into the book field and the bindery and in which it would seem there could not be a separating of units whereby production could be increased, and that is the book gatherer, stitcher, and coverer, as shown in Fig. 9. Gatherers of the type shown have materially aided the bindery in the assembling of books and magazines, and recent improvements have made them still more efficient and accurate in the completion of their allotted work. Large sheets, when folded, become "signatures" in the terminology of the bindery. These signatures are placed in piles and in the proper sequence in pockets at the rear of the gatherer, and at the front there is a series of arms corresponding to the number of signatures that go to make up a book, and having fingers or grippers to seize the signatures as they are drawn from underneath each pile by rubber-capped suction tubes. The suction is created by a new form of continuous vacuum pump and tank in lieu of the old reciprocating pump, an improvement which has materially helped in the continuity of operation. As the gripper arms draw the signatures outward, they are dropped between pins on a traveling chain so that when the last signature is deposited the book is complete so far as its number of pages is concerned. As the chain continues to travel, each book is carried through a wire stitcher which staples the signatures together. A recent improvement in the stitcher, and which has taken considerable time to work out, is to have the stitcher heads so arranged that each one will be a separate unit, permitting the disposition of the staples so that they can be driven in any position desired. This will be recognized in the bindery as a very desirable improvement, tending to better service and increased speed. So sensitive is the gathering machine that single insert sheets or plates as they are called, and which are found scattered through the magazine of today and usually in colors, are taken by the grippers in the same manner as the thick signature, yet if one of these should be missed, or if two thicknesses should present themselves, the machine is immediately tripped and stopped. At the same time a target shows itself at the pile at fault, so that the operator is enabled to quickly correct the mistake and immediately to restart the operation. As the books advance from the stitcher, the back of the book passes over a glue roller, and as it travels on it is met by a cover automatically fed to synchronize with the advancing glued backs and to which the cover adheres. The book is then delivered complete, except for trimming by machines of the type shown in last year's progress report. Once this sequence of machines is started, it must carry through an edition as expeditiously as it is possible to do the work. These machines will gather and cover books at a rate of 120 per minute, and further improvement is being developed to increase this speed.

There is one form of book which is very familiar to us all, and which can be spoken of at this time, and that is the large metropolitan telephone book. While gathered in the usual way, the thickness of the volume bars stapling, and in order to hold the signatures together they are seized in powerful clamps and carried to a horizontal cutter which trims off the back folds; the book is then glued, and a strip of crash is applied just prior to having a cover stuck to it; so that the large telephone book is really a thick pad of separate sheets.

Recent improvements here have very materially made gluing more perfect, for it has always been a matter of difficulty to know that in each book all the sheets are held by the glue and crash. Improvements have resulted in so separating the sheets that the glue has more opportunity to enter between the edges of the sheets; at the same time there must not be an oversupply of glue. This combination of operations, all within one unit, is spoken of because improvements which were the outcome of long investigation and experimentation have resulted in greater facility of operation and perfection of work, and the almost human action of the machine as a whole speaks well of the ingenuity of the engineer in his devotion to continuity, application, and improvement in extant machinery, particularly of that class where mite is so vital in quantity production at fixed intervals.

An unusual application of a well-known material has come to the front in the use of carborundum paper in place of the usual manilla as a packing for impression cylinders on high-speed web presses, particularly of the magazine class. Two instances are cited to show how unusual results of practical value will occur when a means to an end is carefully analyzed and sought for. In the case of the carborundum paper, Mr. A. H. Pugh, Jr.,[2] says: "It is a most useful novelty from my point of view. It is very instrumental in preventing offset to the extent that it is much better and simpler. In the rotary press, in which a traveling tympan is used, it will not only materially help in reducing offset, but it also requires very infrequent cleaning." Mr. T. S. Walling,[3] who has experimented for a long time with the carborundum tympan paper, says: "It is used in our plant because the saving of time, which of course gives increased production, would approximate several thousand dollars per year in the web-press department in the publication of fine periodicals. The carborundum sheet is made up of 280 particles of Aloxite grain to the inch. The web-printed sheet is offset against this fine mesh, resulting in surprising clearness, and excepting in the case of extremely heavy forms, it is not necessary to wash this packing under 35,000 impressions."

So it would seem that printing in its ramifications draws from the field of almost everything in some way or other that concerns the industrial world.

While 1929 may not have shown radical development, nevertheless there have been improvements, and there is a deep investigation now going on in all the machinery, in press methods, and the like, seeking the end that characterizes our industrial activities, better service.

Mr. Joseph M. Towne[4] touches upon a phase of modern development when he says: "The mechanical perfection of high-speed presses has reached new high levels. Modern design has made possible higher speeds. Time and men are being conserved and the machinery in the various departments of production made generally more adaptable and more economical for the general run of work."

At the recent machine-tool builders' exposition at Cleveland, there were some remarks made at one of the meetings that would fit in this report, for, after all, printing and allied machinery are machine tools to a large extent, and the same viewpoint applies to them as to machine tools as we ordinarily think of them. It was there said:

"This is the day of the special-purpose machine. The special-purpose machine is a symbol of the American spirit of industry; never at rest, always seeking to do something better and quicker. The human element is gradually giving way to mechanization, not with the result of doing away with the workman's job, but giving him more leisure time, more playtime, with more intensive work to do and with more machines to handle while he works."

Mr. John Clyde Oswald[5] has expressed some very good thoughts that will bear repeating at this time because they touch upon the man side, particularly as involved in the printing industry. He says:

"From the standpoint of the human unit side of the industry, changes occur slowly. It is made up so largely of small units, that large plants remain an exception to the rule, and the general character of the industry is determined by medium- and small-sized plants. This, together with the small average size of plants, means that a situation of personal relationship between the employer and the employed prevails very largely in the industry. You are probably familiar with the fact that in the reports made to the Census Bureau the number of individual printing plants reporting is larger than is the case with any other industry in America. The degree of trade-union organization, while fairly high for the industry as a whole, varies considerably from city to city, and there are all degrees between the highly open-shop condition in such cities as Los Angeles, Philadelphia, Boston, and Baltimore and the highly organized cities of New York, Washington, and Indianapolis.

"Development of the man power is largely dependent upon apprenticeship work. The printing industry is regarded as a leader in industrial education. It is establishing a research endowment at Carnegie Institute of Technology, and throughout the United States is cooperating with labor unions and local educational authorities in conducting apprenticeship schools. Its system of adult education is also important. Apprenticeship training has been recognized in the work of certain individual plants, the R. R. Donnelley plant in Chicago standing out in this respect.

"Owing again to the small size of the average plant, there has not been much done in the industry in the development of wage-incentive plans or scientific management. There is practically no piecework in the industry except in certain almost unskilled tasks in the bindery. On the whole, the labor problem in the industry is that of developing skill in its employees rather than the technique of mass production.

"Since the industry is largely of a made-to-order nature, labor can be replaced by machinery only within certain limits, and individual skill will remain an important factor."

One can see, from the foregoing, that it would seem there is opportunity for greater development. This leads to the thought that the same question is involved as in other industrial branches, and that is the deep consideration that is being given to the man side, in education, length of work period, some leisure for the working people, and the building up of adequate compensation. This has led to the consideration of a factor that has been rarely thought of in its relation to industry. There is a mass of opinion on production and on intensive selling, and though the thought may seem hardly worthy of mention, nevertheless there is the factor of buying that enters into our general economics. True, men and women of wealth are doing a great work in their contribution to the general welfare of the people, but it is the class of industrial workers that constitutes the real purchasing power of the country, and in reasoning this out, it would seem that if this great mass of people were enabled to have periods of playtime, and while at work their work would be more intensive, still in the finality there would be more time and really more incentive to buy, and thus keep the wheels of industry turning, were time given for working people to realize that they could exert intensity of purpose in their leisure time as well as in their work hours.

We know very well of comments that have been made on recent unfortunate situations in labor conditions here and abroad and leading to the idea that perhaps here is opportunity for further consideration. The printing industry with its opportunities offers a good field for the application of comprehending Engineering in Industrial Humanities. An excellent expression of this thought is well summarized by Mr. McFarland when he says, "As I see it, printing as the basis and support of all modern industrial and social progress, needs continually better engineering," and this applies to the man as well as to the material side. And in further emphasis, President Hoover has expressed himself in part of his Dearborn address of tribute

[2] President of the A. H. Pugh Printing Company, Cincinnati, Ohio. Assoc. A.S.M.E. Mr. Pugh heads a business over a century old.

[3] Superintendent of the McGraw-Hill Publishing Company, Inc., New York, N. Y.

[4] Vice-President, National Blank Book Company, Holyoke, Mass. Mem. A.S.M.E.

[5] Managing Director of the New York Employing Printers' Association. Mem. A.S.M.E.

to Mr. Edison at "The Golden Anniversary of Light" as follows:

"I may emphasize that both scientific discovery and its practical application are the products of long and arduous research. Discovery and invention do not spring full grown from the brains of men. The labor of a host of men, great laboratories, long, patient, scientific experiment build up the structure of knowledge; not stone by stone, but particle by particle. This adding of fact some day brings forth a revolutionary discovery, an illuminating hypothesis, a great generalization, or a practical invention.

"Research both in pure science and in its application to the arts is one of the most potent impulses to progress. For it is organized research that gives daily improvement in machines and processes, in methods of agriculture, in the protection of health, and in understanding. From these we gain constantly in better standards of living, more stability of employment, lessened toil, lengthened human life and decreased suffering. In the end our leisure expands, our interest in life enlarges, our vision stretches. There is more joy in life."

So ends the 1929 report, and let it here be said, the Printing Industries Division of the Society is imbued with that broad spirit of research and achievement so characteristic of the engineering activities in America and, in the case of printing, of such world-wide import to the peoples of the earth. There is none other greater guide and educator than the printing press in its mission of service, never dying, ever living.

Progress in Railroad Mechanical Engineering

Contributed by the Railroad Division

Executive Committee: R. S. McConnell, *Chairman*, M. B. Richardson, *Secretary*, A. F. Stuebing, Eliot Sumner, A. G. Trumbull, and J. B. Ennis

FUNDAMENTAL conditions in the railroad field show little change since last year. Developments in operation and traffic are still following the general trends and tendencies noted in the preceding report of this division. However, the present situation discloses some distinct changes from that of a year ago. The volume of freight traffic in 1929 has been greater than in any previous year; the average weekly car loadings for the first nine months have been 1,051,000, or 7.5 per cent greater than in 1928. While new records for operating efficiency have been established and the ton-miles per freight car have been increased, the surplus of freight cars has declined from the high level of 1928. This apparently has been responsible for renewed activity in the purchase of equipment. For the first nine months the number of freight cars ordered totaled 66,190. Although this number is small compared with record years, it is 169 per cent greater than purchases in the corresponding period of 1928. Locomotives ordered up to October 1 totaled 672, or 170 per cent more than for the first nine months of the preceding year. The tonnage of rails purchased has been large and the major proportion has been of heavy section, indicative of the railroads' purpose to improve their properties and reduce maintenance costs by investments in the most modern facilities.

The continued growth of passenger travel by highway buses has led the railroads to enter this field more extensively and to coordinate train and bus service. The schedules of through trains on trunk-line and western routes have been reduced and more fast trains have been put in service, especially between New York and Chicago. Advocates of the use of inland waterways for freight transportation have been very active, but their arguments have been offset by the reports of independent analysts who have shown that in practically every case the apparent savings in freight rates are more than offset by the fixed charges on the cost of making the routes navigable and providing necessary facilities. A survey of technical developments reveals many innovations in equipment. The variety of designs and types of locomotives is particularly noteworthy.

High-Pressure Locomotives

The interest in locomotives operating at high pressures and the extent to which this means of increasing thermal efficiency is gaining acceptance are evidenced by the numerous designs now being tried. Double-pressure locomotives of the type originated by the Schmidtsche Heissdampf Gesellschaft and described in the paper by R. P. Wagner presented at the 1928 meeting of the Society, have been placed in service on the London Midland and Scottish and the Paris-Lyons-Mediterranean. Similar designs are now being prepared for the New York Central and the Canadian Pacific.

Another high-pressure locomotive built recently in Germany is the Schwartzkopff-Loeffler type, utilizing steam at pressures of approximately 1500 lb. per sq. in., which will be tested on the German State Railways.

The Swiss Locomotive and Machine Works of Winterthur has built a passenger locomotive of novel design with a geared uniflow engine connected to the driving wheels through a geared jackshaft. The boiler pressure is 850 lb. per sq. in. In comparative trials with a locomotive of standard type this design showed a coal saving of 35 per cent.

H. N. Gresley of the London and North Eastern has prepared a design for a high-pressure locomotive to be fitted with a Yarrow-type boiler.

After several years' experience with two locomotives operating at pressures of 350 and 400 lb., the Delaware & Hudson has placed an order for a third which will carry 500 lb. boiler pressure. The engine will be of the cross-compound type.

Turbine Locomotives

Various arrangements for adapting steam turbines to locomotive service are being tried, of which perhaps the most significant is the use of the non-condensing turbine. The Oxelosund-Flen-Westmanlands Railways have ordered two locomotives with back-pressure turbines designed by the Ljungström Steam Turbine Company, which will be built by Nydquist & Holm. The advantages expected are 25 per cent greater starting tractive force than with the reciprocating engine and 20 per cent fuel saving, with a probable reduction in maintenance expenses. The Ljungström Company further proposes the conversion of piston locomotives to non-condensing turbine locomotives by replacing the cylinders with a back-pressure turbine driving through reduction gears and a jackshaft.

Internal-Combustion Locomotives

During the past year the Canadian National Railways placed in service the most powerful oil-electric locomotive ever built. This is especially noteworthy because it is the first of the internal-combustion type which approaches the power output of the modern steam locomotive. Two units make up the complete locomotive, which weighs 650,000 lb., with 480,000 lb. on the driving wheels. The wheel arrangement is of the 4-8-2-2-8-4 type. Motive power is provided by two 12-cylinder Beardmore high-speed solid-injection oil engines of 12 in. bore and 12 in. stroke, rated at 1330 hp. at 800 r.p.m. The fuel consumption of the engines is 0.43 lb. per hp-hr.

A comparison of this locomotive with the latest steam locomotives for passenger service on the same road shows that from 20 m.p.h. to maximum speed the steam locomotive develops slightly greater tractive force, but below 20 m.p.h. the advantage is in favor of the oil-electric which develops a tractive force up to 100,000 lb., whereas the maximum for the steam locomotive is 49,600 lb. Designs have been prepared for a similar locomotive for freight service, which will develop a maximum tractive force of 130,000 lb.

The Baldwin Locomotive Works has recently built an oil-electric locomotive designed for switching service and equipped with a 1000-hp. Krupp Diesel engine. This locomotive, which has a total weight of 270,000 lb., is carried on four pairs of drivers in two articulated four-wheel trucks. The engine is of the four-cycle airless-injection type with six cylinders of 15 in. bore and 15 in. stroke, operating at 250 to 500 r.p.m. A compressor attached to the engine furnishes air for the brakes, for starting, and also for supercharging the engine at about 6 lb. per sq. in. pressure. The generator and four motors operate at 550 volts d.c. The theoretical tractive force is 67,500 lb. up to 5 m.p.h. The control equipment is arranged so that the locomotive can be operated from either end. A noteworthy innovation is the arrangement for varying the speed of the oil engine as required, which consists of a connection by levers and hydraulic cylinders from the electric controller to a cam on the governor which manipulates the throttle of the engine.

Another noteworthy design is the 900-hp. Diesel-electric passenger locomotive built by the American Locomotive Company for the New York Central. This has four-wheel trucks at each end and eight driving wheels in the main frame. The engine is a 12-cylinder "V" type built by McIntosh & Seymour. The cylinders are 14 in. in diameter by 18 in. stroke, and develop 900 b.hp. at 310 r.p.m., with 10 per cent overload capacity. Air injection is used and fuel pumps are governed by electric regulation which controls the amount of oil supplied to the cylinders and the torque developed. The main generator has 10 main poles and 10 commutating poles, and is connected directly to the engine.

The Krupp Works have built a Diesel locomotive with a mechanical-magnetic transmission for the Boston & Maine, which has not yet been delivered. The total weight is 314,000 lb. and the maximum tractive force 50,000 lb.

The first application of the Still combined internal-combustion and steam engine to railway traction has been embodied in a locomotive built by Kitson & Co., Leeds. The motive power consists of a four-stroke heavy-oil engine of the horizontal opposed type with eight cylinders. The cylinders and crankshaft are in a plane slightly above the top of the locomotive frames. The engine is geared to a jackshaft which drives the wheels through connecting and coupling rods. The water jackets of the internal-combustion cylinders are coupled by pipes to a boiler located above the engine. This boiler supplies steam which can be applied to the inner sides of the pistons for starting or to furnish auxiliary power on steep grades. The boiler carries a pressure of 200 lb. per sq. in. and is fired when needed by an oil burner. Heat is also applied from the exhaust gases of the oil engine.

The locomotive is of the 2-6-2 type with 60-in. drivers and weighs 195,000 lb. The engine is of $13^1/_2$ in. bore and $15^1/_2$ in. stroke, designed for a maximum speed of 420 r.p.m., corresponding to a locomotive speed of 40 m.p.h. The fuel is injected without air. On trial runs the engine has commenced to fire at 3 m.p.h. and has operated at speeds up to 45 m.p.h. The tractive force developed was 25,000 lb. with steam alone and 7000 lb. at 45 m.p.h. with internal combustion only. Test runs have been made on the London and North Eastern Railway with both freight and passenger trains. The incomplete data now available indicate that the oil-engine consumption was approximately 10 lb. per 1000 gross ton-miles. It is anticipated that the fuel consumption of the boiler will under average conditions approximately equal the engine consumption. While these figures are far below the best records for steam locomotives in similar service, it is thought that the Still locomotive will give its best results on longer runs with fewer stops and less severe grades.

The most noteworthy locomotive of what may be considered the standard type built during the past year was the single-expansion articulated 2-8-8-4 design for the Northern Pacific, the largest and most powerful steam locomotive in the world. The total weight of engine and tender is 1,116,000 lb., of which 715,000 lb. is the weight of the engine alone. The tractive force of the main engines at 70 per cent cut-off is 139,900 lb., and with 13,400 lb. additional tractive force developed by the booster, the combined tractive force is 153,300 lb.

The Northern Pacific locomotive is especially designed to burn eastern Montana sub-bituminous coal which is high in moisture and has relatively low heating value, necessitating the use of a boiler with 182 sq. ft. of grate area to develop the power required. That the problems involved in the design were successfully met is indicated by the fact that the railroad has placed a second order for locomotives of the same type.

Another interesting development in special fuel is the application of pulverized fuel in Germany. Two different designs are being tried. One has burners extending along both sides of the firebox with multiple slots and water-cooled chambers, the jets impinging against one another in the middle of the firebox. The other type has a diffuser burner in the form of a hollow cone, the enlarged front end of which is closed by a plate having numerous nozzle-shaped holes. The small rear end adjoins a mixing device for the coal dust and air mixture. The diffuser plates are flush with the back plate of the firebox, while the burner bodies are outside. The diffuser plate, which is the only part exposed to radiant heat, is cooled by the coal dust and air mixture.

Freight Cars

The most significant development during the year pertaining to car equipment was the report of the draft-gear tests conducted by the Mechanical Division of the American Railway Association. Following extensive laboratory investigations of draft gears now in general use, the committee submitted tentative specifications setting forth requirements for capacity, sturdiness, endurance, and recoil. The work of the committee will be carried still further, and it is expected that important improvements in draft gears will result from their investigation.

Further extension of the use of special refrigerating systems mentioned in previous reports is indicated by the announcement that the company developing the silica-gel system of refrigeration has placed an order for 50 additional refrigerator cars to be so equipped.

Progress in Textile Manufacturing

Contributed by the Textile Division

Executive Committee: Edwin H. Marble, *Chairman*, McRea Parker, *Vice-Chairman*, Wm. L. Conrad, *Secretary*, Earle R. Stall, Henry M. Burke, and Paul A. Merriam

THE year 1929 has shown a marked improvement in the attitude of textile-mill owners toward the adoption of better machinery and methods. Consequently, the more progressive manufacturers have been able to improve their product and at the same time reduce their costs, with the result that many are showing profits while the industry in general is considered to be still in a state of depression. At the same time, many mills of proved inefficiency, for want of progressive leadership or capital, have been forced to close. Continuation of this trend will inevitably bring to the front a group which will continue in business and make money, while others will have to go out of business, and the result will be to put the industry in a healthy situation again.

The machinery manufacturers, appreciative of this situation, are bending their efforts to improve their equipment, and those that are successful are taking orders. This improvement is generally shown in the adoption or more general use of anti-friction bearings, cut gears, etc., in an effort to reduce vibration to a minimum.

Demand for Engineers

As a result of this tendency toward improvement in methods within the factory and the machinery developed for the industry, there is an increased demand for trained men from textile and engineering schools. The plant engineer has definitely taken his place in industry, and the more progressive textile concerns are availing themselves of his services. This is resulting in a breakdown of many of the rule-of-thumb methods, and the substitution in their place of machinery and control based on scientific principles.

This interest in scientific methods has created a demand for more and better equipment for the testing of materials at various stages of manufacture. As an example of this, an improved machine has been placed on the market during the year for bursting tests on knitted fabrics which gives more uniform results than previously were obtainable.

Humidity Control

There is a growing appreciation of proper humidity and its accurate control, and this is being applied not only in more mills than formerly, but over a wider range in the individual mill. Numerous installations have been made during the year. Developments in this line will undoubtedly lead to more knowledge of the subject and to improved control.

New Materials for Machinery and Equipment

In the effort to obtain improved operation of machinery, there has been a search for improved materials of construction, and some of the newer materials, such as those embodying artificial resins of the nature of bakelite, have been introduced. These have found their place in bobbins, spools, pickers, etc. In rayon manufacture, alloy metals have to a considerable extent replaced glass where acid-resisting qualities were required.

Rayon

The processes and machinery employed in the manufacture of textiles are fundamentally similar though used on various raw materials. These latter include the so-called "synthetic fibers," generally referred to as rayon, but because this material is a chemical product and relatively new, whereas other textile materials are natural and have long been in use, it appears well to give it separate consideration.

The marked increase in the output of rayon is in itself worthy of note. Factories have continued to spring up in almost mushroom fashion, both in this country and in Europe. Many European concerns are establishing factories in the United States an Canada. As result of this growth, and the concurrent demand for the product, the output of rayon for the calendar year 1929 can be safely estimated at close to 400,000,000 lb. This phenomenal growth is significant, for it brings out the fact that rayon is replacing other materials as well as finding novel uses of its own. Much machinery previously used on other fibers is being converted to the use of rayon, while at the same time new machinery is being designed for its special use. Considerable progress has been made in this direction during 1929.

While rayon is still manufactured under four basic processes, namely, the viscose, acetate, cuprammonium, and nitrocellulose, many modifications have been made in these with the result that a near approach has been made to real silk, both in fineness and appearance. At the same time its other properties have been improved, resulting in greater resistance to heat and better affinity for dyes. Hosiery made entirely of rayon is now a fact, and a rayon sewing thread has been placed on the market during the year.

Preparation of Fibers

In the matter of preparation, which applies in general to all forms of raw textile material, greater attention is being paid to grading and cleaning of the material used. This has been especially true in cotton, because of attempts to use lower grades which are mechanicaly picked and less carefully ginned. This has resulted in radical improvements in machines for opening, blending, cleaning, and picking. Machinery which has been developed for cotton has found application, with some minor alterations, to wool, with substantial results. This dual application has permitted some degree of standardization, with resulting economy in manufacture and sale of this equipment.

Carding

In carding, greater attention is being paid to more uniform webs, with corresponding reduction of variation in counts. To this end, a more accurate weigh box has been introduced during the year and an improvement made on the Scotch feed. This improved feed lays a wider and thinner sliver than previous feeds, permitting a greater degree of overlapping of the sliver, with correspondingly greater smoothness and uniformity in the rovings taken from the card.

Cut rayon stock, too, is being carded with a greater degree of success through the better working knowledge of materials and special arrangements for their proper handling. Proper control of humidity and temperature has played an important part in this improvement.

Advances have been made in the kind and quality of oil supplied the textile trade for the lubrication of the stock. Research has produced oils of mineral bases which are successfully replacing the more expensive vegetable oils. Greater attention is being paid in the mills to the kind and quality of oil used and its method of application, resulting in better working of the stock.

Spinning

Perhaps the outstanding development in spinning is the application of variable speed to the spindles. This permits giving more equal tension to the yarn throughout the spinning cycle. Unequal tension was the result with constant-speed spindles because of the tendency of yarn to become tight where the effective diameter of the bobbins was small, and loose where this diameter was large. Variable speed permits greater production per spindle, as the maximum speed of the spindle is no longer determined by a condition which exists but a fractional part of the working cycle.

Variable speed has been accomplished generally by the use of variable-speed motors directly connected to the individual frames without clutches. In Germany successful experiments are reported in the use of individual motors on fliers.

Another development which is not new but which has received a great deal of attention during the past year is the so-called "mule spinning frame" for spinning woolen yarns from roping taken off a woolen card. This type of machinery has been on the market for several years, but recent improvements have materially altered it so that frames are now available over quite a range of counts. Outstanding among these improvements is the divorcing of the draft rolls from the spindles and driving them independently of each other so that the most productive speed can be assigned to each.

Weaving

Power looms are now designed especially for rayon. These looms are fundamentally the same as the ordinary loom, but have refinements and features which adapt them better to rayon.

The automatic loom has been improved by constructing it heavier and by using anti-friction bearings for the main journals. In addition, more attention has been paid to the kinematics of design, resulting in harness motions of smoother acceleration and head motions freer of variation caused by the picker action. The result is a loom which runs with less vibration and consequently at a higher speed than heretofore has been considered practical.

There is a tendency toward a greater use of the electric types of stop motion since these have been improved over the older electric devices. One of the larger loom manufacturers has conducted successful experiments along this line, and will no doubt offer its improved device to the trade in the near future.

Out of the electric stop motion has grown the idea of complete electric control of the loom. This is accomplished by equipping the loom with an individual motor of the double squirrel-cage type, which is capable of giving a high starting torque when thrown directly across the line. This permits a push-button control of the motor, with resulting facility of starting and stopping the loom from any working position taken by the weaver, which is an obvious advantage.

In the manufacture of rugs there has been a general movement toward looms of greater width in order to meet the demands of the trade. Looms capable of weaving fabrics 15 ft. wide are not uncommon, and equipment for widths up to 20 ft. has been installed. This has involved some very serious problems in design on the part of the machinery builder.

Of passing interest in this connection is a machine capable of making rag rugs by a braiding process. Rag carpeting is now available for the householder of modest means.

Dyeing and Bleaching

With the growing demand for color, new dyes have been introduced which give brighter colors, dye more successfully in neutral baths, and are better able to withstand hard wear. The insistence on fast colors is more general. The use of vat colors has increased on rayon, cotton, and mixed fabrics, also on woolen and worsted fabrics, and to some extent on felts. Dyes have been developed for especial use on rayon with more uniform results. Peroxide bleaching is finding greater use in the bleaching of cotton yarn and piece goods. It is also being used to a greater extent on woolen piece goods to meet the present demand for bleached fabrics in women's wear.

The changing attitude toward technical and automatic control is exemplified in dyeing and bleaching.

Finishing

Marked progress is developing in the direction of grouping finishing-plant machinery in series or ranges. This, among other important advantages, secures elimination of the intermediate handling. Three methods are employed which use, respectively, variable-speed motors, by which variable speed and synchronism are obtained electrically; constant-speed motors or mechanically driven shafts, speed variation being obtained through a mechanical speed changer; and variable-speed steam engines, where control is obtained through the governing mechanism. It is anticipated that this form of operation will eventually be extended to other departments of the industry.

The gradual but certain influence of the cutting-up trade has never been more in evidence than in the past year. Today a wool fabric must be finished, ready for the needle; there must be practically a permanent set not affected by the steam pressing now almost universally used by clothiers, this steam pressing taking the place of the former hand pressing or ironing which the earlier tailors thought necessary. The fabric is subjected to a processing that gives it a clean, even luster, a feel pleasing to the touch, and a set or permanent conditioning that can be depended upon. Several types of machines have been introduced, all embodying the same general principles of steaming the fabric when rolled upon a cylinder, while enclosed in a mantle or wrapper, and exhausting the steam from the body before removing it. This is the system of open steaming, as contrasted to the older closed steaming formerly much in use.

In the cotton trade the changes have been less radical. The use of rayon has brought about a demand for lighter machinery, but of higher speed capacity and capable of closer adjustment. In some types of magazine looms the filling yarns project beyond the selvage and have to be cut off. This has brought into the field shearing machines with nicely adjusted cutting parts and suction devices adapted to bring the projecting ends into the cutting parts, which remove the imperfections without damage to the fabric.

In general, practically all machinery in the finishing departments for all fabrics has had to be redesigned to meet the call for increased speed in the various processes.

Knitting

The production of heavy knitted fabrics closely resembling the woven product has caused no little interest and speculation in the textile field. These fabrics are closely bodied and are finding a ready acceptance for top coatings and heavy overcoatings. The fact that a knitting machine produces this fabric many times as fast as a loom could produce its equivalent, has given the weaving trade some food for thought.

Conclusion

This report outlines some of the developments in the textile field during the year. The Committee feels that it is indicative of the greater place which the engineer and engineering methods are taking in the industry. There is need for a freer exchange of ideas among the engineers if the benefits of their practice are to become more general and more pronounced. The textile publications are helping to this end, and it is notable that the leading textile journal of Europe is now publishing an American edition. The Textile Division affords a forum for engineers engaged in the industry. To such extent as textile engineers avail themselves of this opportunity, will they promote the industry to the same healthy basis enjoyed by other industries in this country.

McRea Parker, *Vice-Chairman.*

Progress in the Wood Industries

Contributed by the Wood Industries Division

Executive Committee: Wm. Braid White, *Chairman,* Chester L. Babcock, *Secretary,* James S. Mathewson, Thos. D. Perry, and A. S. Kurkjian

SUBSTANTIAL progress throughout American woodworking and wood-using industries may be reported for 1929 in all technical and commercial aspects. Thus, in the field of woodworking machinery we find a still stronger tendency toward the use of individually motorized machines. Moreover electric current as the power source has now become so common a feature of woodworking factories as no longer to call for special comment. This again is leading to the general adoption of a standard of current, in this case alternating, at 60 cycles.

Power

There is also arising a tendency to employ Diesel engines for driving electric generators. Steam plants for generating current are adopting automatic shavings-feeding apparatus for the boilers. Better methods of burning waste wood are coming steadily into use, while at the same time there is a definite tendency to explore the use of what is known as "wood flour" (pulverized wood refuse) for fuel.

In certain plants the idea of sequential operation has been carried out to considerable lengths, especially in the upper Mississippi River district. In cutting departments of sash-and-door and similar plants, conveyor machinery is being installed for handling materials and advancing assemblies.

Short-length lumber is becoming sufficiently important to justify the construction and use of special machinery for using it in manufacture. A foreign-made gang saw has been introduced with some success for cutting small logs which hitherto have been left in the woods owing to the lack of any practical method of dealing with them.

Another interesting new machine is the electric-driven 4-in. molder, which is lighter and more convenient than other machines hitherto commonly used, and which is especially appropriate because of the fact that the greater quantity of all wood molding used is less than 4 in. wide.

Automatic ejectors for use with wood-turning lathes, to eject the finished stock, are being used. High-speed motorized machines are being fitted with automatic electric stopping brakes for cutterheads.

Other electric machinery recently coming into use includes the 2–4-pole motor, or two motors in one, which can be run at extremely high speeds, as high in fact as 9000 r.p.m. with 150-cycle current, and with a minimum speed of 4500 r.p.m.

An automatic clip saw for cross-cutting, which insures greater safety and higher speed, is also coming into use. So is an automatic shaping machine of the rotary-table type. So also is a "wood stamping" machine which simultaneously bores and embosses carved work through a hot-press process. This is being used on plywood work.

Lumber

The grade marking of lumber is becoming a regular practice, and by degrees the consuming trades are coming to demand this additional security, although so far only on softwoods. Hardwood grade marking is being heard of, but is as yet a matter of discussion rather than of practice.

There has been a great increase in the use of "wood flour" for the manufacture of bakelite and similar composite materials. The use of end-matched lumber is undoubtedly increasing. Plywood shows constantly widening uses, in the sash-and-door and the radio-cabinet fields. Radio cabinets have afforded the largest single outlet for plywood construction during the year, and some factories are demanding stock for outputs at the rate of thousands of sets daily.

Research

The search for a perfectly water-resistant glue still goes on. The Forest Products Laboratory of the U. S. Forestry Service continues to do work of the highest grade in this investigation. It has been shown that under certain conditions and within certain limits, animal glue may be made water-resistant to an extent that is useful if not complete.

Researches in the following fields are being actively carried on at the Forest Products Laboratory:

1 Determination and classification of characteristic defects of different wood species from different regions.
2 Determination of differences of density in woods of different species.
3 Survey of moisture content in softwoods.
4 Study of standard measurements of the inflammability of wood to determine the fire-resisting properties of different species.
5 Study of better methods of finishing wood.
6 Study of the effect of grain direction upon the quality of glued plywood panels.
7 Study of the strength of various wood sections, mainly for aeronautical purposes.
8 Study of the holding power of various types of nails and screws.

A.S.M.E. Committees

The research committees appointed by the Society at the request of the Wood Industries Division have been carrying on their

investigations with fruitful results. The Spark Arrester Research Committee has already made certain practical recommendations as to the design and construction of spark-arresting apparatus for use with steam and internal-combustion engines working in woods and forests. Tests in accordance with these recommendations are to be made on spark-arresting apparatus in the near future, by the Oregon State Agricultural College.

The Research Committee on Saws and Knives has pursued its course. The interest, and to some extent the collaboration, of the manufacturers of saws and machine knives is being secured, and the Committee expects to carry on its work to a fruitful end.

Meanwhile the New York State School of Forestry is giving courses in the utilization of wood. Work is being done on better methods for applying preservatives to wood, and a process of pre-treating and finishing wood has been announced which, among other things, will permit the laying of floors ready finished.

Merchandising Study

In general, the whole question of more scientific methods of merchandising lumber, and wood products generally, is being studied. Wood is today compelled to withstand the competition of many materials offered as substitutes for it. The problem of selling wood products therefore becomes more and more obviously one of scientific preparation and planning. The lumber associations, the societies of manufacturers, and other bodies are giving an attention to these matters which is not the less welcome for having been so long delayed.

Miscellaneous

Among the various interesting activities in the woodworking field may be noted the practice of shipping furniture in plywood boxes instead of in crates; the enormous increase in the use of plywood for the construction of radio cabinets; the gradual but steady transformation of the so-called "sash-and-door" factory into a plant manufacturing all kinds of builders' woodwork; and the general, though gradual, alignment of the wood industries with their younger rivals in their attitude toward the public and toward each other.

The excellent book "Wood Construction," by the Assistant Director of the National Committee on Wood Utilization, Department of Commerce, should be signalized as one of the important features of the year in our field. This is by all odds the best work of its kind which has yet appeared, and should be in the hands of every practical woodworking engineer.

Those, and they are not a few, who still think of the woodworking industries in terms of carpentry and the portable lumber mill, are invited to read the report of fifty years' progress in these industries which forms part of the Society's proceedings for the jubilee year. Today, one may fairly affirm, in machinery, in methods, in accuracy, and in speed, the wood industries can compare favorably with any of the mechanical-engineering branches. It is extremely unfortunate that technical schools and colleges have not long since recognized the evolution of woodworking methods; but for this neglect on their part, which has led to a dearth of trained wood engineers, the industries are themselves mostly to blame. Engineers will tend of course always to go into those fields which show themselves attractive. Only within the last few years has the great importance of wood engineering come to be recognized in any part. For speeding this recognition the Division feels that it may justly claim some credit.

Work of the Division

During the year now past, the Wood Industries Division has been active. Its national meeting at Rockford, Illinois, in October, was the most successful it has yet held. The Division is not unmindful of the fact that, small in numbers as it was and remains, it was the first of the Professional Divisions to hold a national meeting after the decision to allow such meetings had been announced. It has since that time held them regularly each year.

Wood engineering now takes its place as one of the definitely recognized branches of the mechanical-engineering profession. The Wood Industries Division of the Society is pledged to deepen and intensify this recognition. The present writer has been honored by his colleagues with the chairmanship of the Division for four successive years. In retiring from it, at the expiration of his term as a member of the Executive Committee, he believes he can claim to have seen each year a general improvement of woodworking engineering along lines both technical and commercial.

William Braid White, *Chairman.*

A Controllable-Pitch Propeller

In THE early days of aviation, the desirability of the controllable-pitch propeller was recognized, but with the advance in the art, desirability is rapidly changing to necessity since aeronautic engineers now realize that they must have controllable-pitch propellers to develop the full capabilities of the airplane as an established means of transportation.

If the added weight can be kept reasonably low, the great advantages in performance resulting from the use of a propeller that will give good efficiency under all conditions of flight and also allow the full power of an engine to be developed when most needed will offset many times the disadvantage of a heavier propeller.

Greater efficiency of flight will effect a large saving in fuel, and the use of controllable-pitch propellers will also result in longer engine life and avoid the necessity for frequent engine overhauls. For these reasons the added cost of controllable-pitch propellers should be made up in a few hundred hours of operation.

The author refers particularly to the Turnbull electrically controlled propeller which is now being developed by the Curtiss Aeroplane and Motor Company. This propeller is now designed with a duralumin blade extending into a steel hub, and with this construction a very rugged ball-thrust washer can be introduced to carry the high centrifugal load of the blades.

To get fine adjustments of pitch angle and to enable a very small electric motor to handle the centrifugal and thrust loadings, reduction gears having a ratio of 48,000 or 64,000 to 1 are used, which gives the pilot about the correct rate for blade-angle changes, namely, two to three seconds of time for one degree of angle. Besides the really essential feature of slow and fine blade-angle adjustments and ready means of power transmission through brushes, the adoption of electricity lends itself to the introduction of any indicating and automatic safety devices that may be desired. Since also the control is entirely independent of the engine operation, the blades of the propellers on a multi-engined aircraft can be swung into a feathering position on a dead engine, and, where desired for dirigible work or the like, the propeller can be reversed while the engine rotation continues to be unidirectional.

In the first all-metal Turnbull propeller, the 200-hp. class at 1800 r.p.m., the weight of all rotating parts was 128 lb., but in the second design of this class the weight had been reduced to 107 lb., and future designs probably will not run much over 20 to 30 per cent greater than the weight of the corresponding fixed-pitch types.

In the Turnbull type of propeller the range of the angle change is not limited, and any desired range can be incorporated in the design.—*Society of Automotive Engineers' Journal*, Oct., 1929.

Survey of Engineering Progress

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICAL ENGINEERING

High-Temperature Liquid Cooling

COOLING internal-combustion engines by liquids other than water to permit operation of the cylinders at higher temperatures is a comparatively old idea, but no practical working application had been made until recently, because of failure of the various liquids to meet one or more of the requirements imposed and because of the structural details of the engines in which they were tried. The paper here abstracted states the requirements that such a liquid must satisfy and gives a brief history of the art. It deals particularly with the work at Wright Field. There ethylene-glycol was used. This is marketed as an automobile anti-freeze material under the name "Prestone," and is a clear, colorless, highly hygroscopic odorless liquid boiling at 387 deg. fahr. and freezing at approximately 12 deg.

In some of the tests considerable trouble developed such as leakage of Prestone through the various joints and cracking of parts.

The engine operation in the airplane, however, was very satisfactory and the performance and maneuverability of the airplane were improved. The maximum cooling-liquid outlet temperature recorded in level full-throttle flight was 285 deg. fahr. with a ground-level air temperature of 85 deg. fahr. No oil cooler was provided.

Further laboratory work was carried on with the D-12 engine by combining high compression ratio, high-temperature liquid cooling, and high rotational speed. An engine prepared for high-temperature operation was fitted with pistons giving a compression ratio of 7.3 to 1, and some very remarkable results were obtained. The tests were made with the engine connected to the dynamometer as before. The fuel used was California fighting-grade gasoline plus 11 cc. of 1 T ethyl fluid.

Full-power calibration curves from 1800 to 2600 r.p.m. with 300-deg. fahr. Prestone outlet temperatures are given in Fig. 22 in the original article. The engine developed 522 b.hp. at 2600 r.p.m. and 488 b.hp. at 2300 r.p.m. The maximum brake mean effective pressure was 146 lb. per sq. in. at 2000 r.p.m. The power output was 12 per cent greater than the rated power at the normal speed of 2300 r.p.m. with 5.6 to 1 compression ratio and 180 deg. fahr. jacket temperature.

There is a saving of 20 per cent from the normal specific fuel consumption of 0.500 lb. per b.hp-hr. with water and normal compression ratio at best setting, throughout the full-throttle speed range. The specific fuel consumption is also remarkably constant throughout the range of speeds, varying only from 0.407 to 0.415 lb. per b.hp-hr.

The best-setting specific fuel consumption is 0.401 lb. per b.hp-hr. at 2600 r.p.m., and it gradually rises to 0.464 lb. per b.hp-hr. at 1800 r.p.m. The full-rich and best-setting specific-fuel-consumption curves are very close together from 2300 to 1800 r.p.m. The propeller-load best-setting specific-consumption curves based on 2300 r.p.m. are flatter, varying from 0.399 lb. per b.hp-hr. at 2200 r.p.m. to 0.422 lb. per b.hp-hr. at 1800 r.p.m. with the best setting of the mixture control.

The results of the investigation indicate that the modern water-cooled aircraft engine, with minor changes, can be operated successfully and more efficiently at a cooling-liquid temperature of 300 deg. fahr.

Operating an engine at this temperature entails a sacrifice of approximately 3 per cent in power, but the loss in power is minor when compared to the advantages obtained by better fuel economy: reduction in the size of the radiator, the amount of cooling liquid, the weight of the engine installation, the parasite resistance of the airplane, and the simple and positive provisions afforded for ample heating of the inlet manifolds.

The following advantages were also found: Better fuel economy, reduction in radiator size, reduction in cooling liquid required, reduction in engine installation weight, and reduction in parasite resistance of airplane.

The combination of high compression and high-temperature cooling results in decreasing the ratio between the installed weight and the power from 2.00 lb. per hp. at the normal rating of 435 hp. at 2300 r.p.m. and the normal compression ratio, to 1.46 lb. per hp. at 535 hp. at 2600 r.p.m. and the higher compression ratio. Further development is in progress which promises to give even a greater reduction in this ratio. This feature, when combined with the other advantages of high-temperature liquid cooling, should result in some very remarkable and heretofore unattained performances in airplanes designed around this system of cooling. (Gerhardt W. Frank, Mechanical Engineer, Power Plant Branch, Material Division, Air Corps, Wright Field, Dayton, Ohio, in *Society of Automotive Engineers' Journal*, vol. 25, no. 4, Oct., 1929, original paper pp. 329–340, 24 figs., and discussion pp. 340–343, *de*)

AERONAUTICS

Training in Instrument Flying

THIS is a description of the Rougerie method as practiced in France. In it the student is first shown by the instructor the operation of the instruments used in blind flying. He tells the student how to navigate by means of these instruments and what steps to take in case of trouble, again as indicated by the instruments. The student is trained by instructors on a training bench until he becomes able to go through the proper motions without hesitating. When fully proficient in this, he is taken up in an ordinary plane by an instructor so that he may compare the indications of the instruments and the actual movements of the plane. Blind flying (i.e., flying where the pilot does not see ground and landmarks) starts with short periods which are gradually increased in length. While flying the instructor uses the aviophone to transmit orders and advice to the student. Blind-flying tests cover starting, straight-line flying, change of direction within a prescribed angle, right and left spiraling, flying in a straight line followed by a correct U-turn and return to the starting point, flying in a circle along the itinerary prepared beforehand on a map with calculation of angles and elapsed periods of time, flying in the clouds, etc.

The apparatus with which the training is carried on consists (1) of a training bench which is used until the student is fully grounded in all that can happen during flight; (2) a F-71 Salmson

plane, which is essentially unstable but which obeys all kinds of maneuvers and can take without serious danger practically any kind of a position; and (3) a Goliath Salmson plane, which is used to complete the course of instruction.

From reports of those who have taken the course, it would appear that several lessons are given on the training bench. The student goes then to the F-71 Salmson plane, which is equipped with a hood to produce an equivalent of blind flying. This hood has a door to permit the flier to escape with a parachute in case of necessity. The hood may be quickly removed when it is desired to use the plane as an ordinary machine. The first lesson in the plane is devoted to familiarizing the pupil with the instruments and getting him to calibrate them more or less. This is done without the hood, and is followed by flight with the hood. During the first flights with the hood the student is in anything but a comfortable frame of mind, as notwithstanding the presence of the instruments he has no idea of where and how he is flying.

Even after the pupil begins to fly he still continues exercising on the training bench. After a couple of days of flying a great change takes place in the pilot's ability to follow the indications of instruments. He begins to acquire a close control of the stability of the plane and can easily sense the progress of the flight. After a few more flights he feels master of his plane, and is then capable of holding closely to a straight line and making correct turns. It is significant that when one of the student officers in his ninth flight got into heavy clouds and attempted to guide the plane without any advice from the instructor, relying exclusively on his personal impressions, he became completely lost after half a minute of flight and could not obtain any clear idea of the position of his plane. He then rose to a higher altitude and began to fly by instrument only, with the result that after several aerobatic evolutions he set the plane in what was indicated to be the correct direction, and came out of the clouds within a mile and a half from the field and exactly in the proper direction. A number of such cases are reported. Among the illustrations is one showing Hon. J. P. MacCracken, Jr., former Assistant Secretary of Commerce for Aeronautics, stepping out of an airplane where he had been shown the application of the Rougerie method of flying. (*L'Aerophile*, vol. 37, nos. 11–12 and 13–14, June 1–15 and July 1–15, 1929, pp. 185 and 214, 2 figs., *d*)

ENGINEERING MATERIALS

A Copper Alloy Capable of Being Hardened

TEMPALOY was patented early in 1928 by M. G. Corson and is controlled by the American Brass Company. Nickel and silicon are present in the proper proportions to form nickel silicide; when heated to 750 deg. cent. or above, the nickel silicide is in solid solution in the copper. It may then be hot rolled or forged. When this alloy is quenched from above that temperature, it is ductile and may be cold-worked. The silicide is precipitated from solid solution when heated for a few hours at 450 deg. cent., causing the alloy to become hard and strong. Annealed Tempaloy can be forged to shape, welded with Tempaloy rod, and then age-hardened to secure increased mechanical strength in the weld as well as in the base metal.

Generally speaking, it is best to use a welding rod of the same composition as the base metal, but Everdur can be used in welding Tempaloy. A fused boric acid flux may be used, but for best results add 10 per cent of sodium fluoride. A backing bar is usually necessary. The flame should be slightly oxidizing to concentrate the most heat upon the weld, and its length must be governed by the thickness of the metal. (Paper by W. R. Hibbard, Technical Dept., American Brass Co., Waterbury Conn. read on Nov. 14, 1929, before the International Acetylene Association; abstracted through *The Iron Age*, vol. 124, no. 22, Nov. 28, 1929, p. 1434, *d*)

Diphenyl

THIS material which has been previously referred to in MECHANICAL ENGINEERING (Vol. 51, No. 8, August, 1929, p. 617), it is claimed, will transfer more heat per pound than will steam within certain limits. Ordinary steam-boiler equipment may be used with diphenyl, with the exception that most of the copper parts must be eliminated as copper is not considered safe due to high temperatures. Boilers in which diphenyl is used must have no dead spots, and positive circulation is advised. Carbonization may occur if the temperature goes over 1000 deg. fahr.

Diphenyl is almost inert and has no corrosive action on any material. It will burn at high temperatures, presumably around 1800 deg. fahr. The original article shows an application of diphenyl in an ordinary water-tube boiler. The diphenyl is recirculated all the time. Other uses for it have been suggested. It is not stated where the boiler described was installed. The original article also gives a preliminary table of values for diphenyl, showing for given temperatures corresponding gage pressures, liquid, latent, and total heat contents, and liquid and vapor densities.

Diphenyl should not be confused with diphenyl oxide, which, it is stated in the original article, is not so stable and has a tendency to carbonize in the tubes. (*Industrial Power*, vol. 17, no. 5, Nov., 1929, pp. 41–42, 146 and 148, 3 figs., *d*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautical Engineering: High-Temperature Liquid Cooling)

The Clarkson Tube Silencer Boiler

THE purpose of this boiler is in part to act as an engine-exhaust silencer, but also to recover from the waste gases some of their heat in the form of steam or hot water. Over 30 per cent of the heat in the usual engine is carried away by exhaust gases. It is claimed that by the use of the Clarkson boiler two-thirds of this loss can be recovered. This boiler is not new, as already in 1925 it was applied aboard the motor vessel *Malabar*. A number of vessels have since been equipped, among others, the latest "Treaty" cruisers for the British Admiralty. The cross-section of a Clarkson boiler is shown in Fig. 1. Its heating surface consists of tubes of the shape of elongated thimbles. The water pulsates rapidly in the tubes and prevents the formation of scale. Each tube is free to expand without strain as it is held at one end only. This is the reason of the remarkable fact that Clarkson tubes never break, even when the boiler is run dry at 1000 deg. fahr. or over. Cold water may be pumped into the hot boiler without danger or injury. The tubes are seamless and capable of withstanding a pressure of 1000 lb. per sq. in. Should the outside of the thimble tubes foul, as may happen when running off a dirty engine exhaust, the boiler can be emptied, a wad of oil-soaked waste ignited and put at the foot of the tube nest, and the impurities can be burned off with no danger of damage occurring.

Clarkson boilers with coal grates have proved very suitable as donkey boilers, for use on dredgers and steam road wagons, etc., where they are in successful operation, in many cases, where the rate of evaporation with coal firing is from 10 to 22 lb. of steam per sq. ft. of heating surface per hour at pressures up to 400 lb. per sq. in. and with superheat up to 700 deg. fahr. (N. Bannatyne, Affiliated Engineering Companies, Ltd., Montreal, in *Canadian Engineer*, vol. 57, no. 16, Oct. 15, 1929, pp. 629–630, 4 figs., *d*)

METALLURGY (See Special Processes: British Die-Tool Treatments)

POWER-PLANT ENGINEERING (See also Engineering Materials: Diphenyl)

An Up-to-Date British Cotton Mill Power Plant

THIS paper describes the remodeling of the power plant at the Victoria Mills, West Leigh, Lancashire, which comprise a group of four cotton mills containing 192,568 mule and 26,272 ring spindles, beaming and reeling frames, and spinning Egyptian counts. Originally each mill was separately driven and three batteries of Lancashire boilers provided steam. The engines were condensing. While the existing power plants had been maintained in excellent condition the arrangements were such that instead of one big mill, the Victoria Mills, as regards power, were really three separate mills with separate staffs of stokers, ash wheelers, and engine tenders. In the reorganization it was

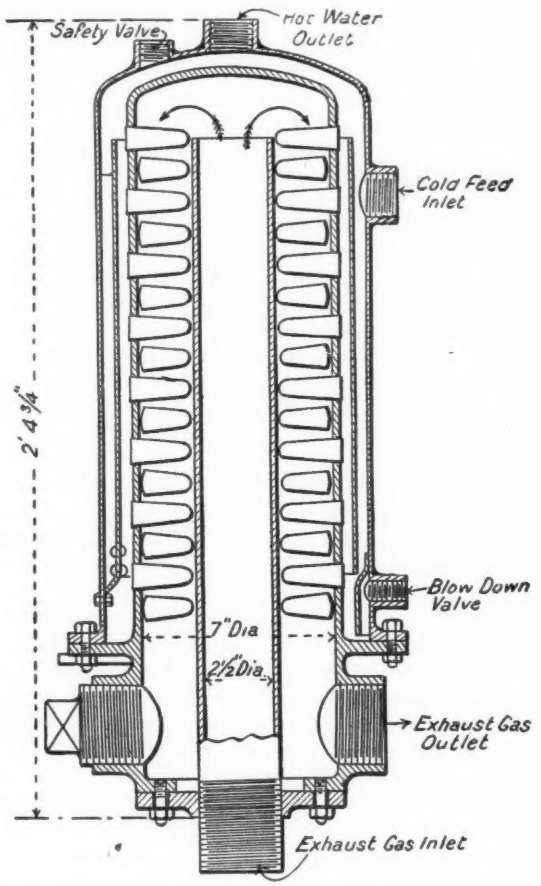


FIG. 1 CROSS-SECTIONAL VIEW OF A CLARKSON SILENCER BOILER
(See abstract on opposite page.)

decided to install a central steam-raising plant to supply all the mills. Three of the mills were to be electrified and driven by a 2000-kw. turbo-generator, while in mill No. 4 the engine drive was retained for the time being but supplied with steam from the new high-pressure boilers through a reducing valve and desuperheater.

The most interesting part of the job is shown by the operating results. Prior to the change-over, the mills operated on 3.3 lb. of coal per i.hp., including mill heating. This is now reduced to 1.66 lb., the weekly coal bill being reduced from 253 to 155 tons, a saving of over 38 per cent on the previous summer consumption.

The cost of power generated over six months' running, including all labor operating costs, coal for heating, insurance, and power-plant maintenance, is 0.304 pence per unit (0.616 cent per kw-hr.) or, including 10 per cent for interest and depreciation on the outlay on power plant, 0.498 pence (1.008 cent per kw-hr.), which, bearing in mind that mill heating would still have to be provided for if power were bought, is a low figure.

Other advantages which have accrued from the change-over are: (1) Freedom from black smoke, a most important factor seeing that the area around the mills is densely populated; (2) two stacks and one large enginehouse have been pulled down, thereby greatly improving the natural lighting of the mills; (3) it has enabled further productive machinery to be installed, including the conversion of No. 4 mill, containing 85,000 spindles, to a combing mill, by utilizing the old boilerhouse, etc., without any extension of buildings; and (4) a distinct increase in production from the existing equipment.

An intesting feature of the installation deals with the treatment of feedwater. The first boiler was operated some months without any system of treatment after the primary treating of the brook water. Experience showed that this was not satisfactory, the scale which formed being very hard. The Filtrator system was then installed (at the time of the delivery of the paper), and has been in operation for twelve months. The boilers each steam at the rate of 21,000–25,000 lb. per hr. during working hours and 2000–4000 lb. per hr. through the night. The conditions are of course severe, as the feedwater is in effect 100 per cent make-up at 4.5 to 7.0 deg. of hardness, and with any system which treats the water in the boilers and economizers there is bound to be considerable deposit.

It was hoped that the Filtrator system, which is simply the injection into the feedwater of colloidal matter distilled off the linseed under pressure, would enable the solid matter previously giving trouble as hard scale to be blown off. The cost of the linseed used (19 lb. per boiler per day) works out at 0.2 pence per 1000 lb. of steam.

While the Filtrator system certainly did prevent the formation of hard scale, experience has shown that even hourly blowing off from the boilers and twice daily from the economizers will not get rid of the sediment, and every four weeks the boilers have to be emptied and cleaned out; with experience probably six weeks would be possible, but the bringing in of the operating staff even every three weeks for boiler cleaning is both costly and apt to cause the men to lose their keenness. The cost of such cleaning puts the cost of treatment up from 0.2 to 0.56 pence per 1000 lb. of steam. (*Proceedings of the Institution of Mechanical Engineers*, no. 3, May, 1929, pp. 491–506, 3 figs., d)

The Deepwater Power Plant

THIS station, on the east bank of the Delaware River, and about 4 miles south of Penns Grove, N. J., seems to be in many ways a very unusual installation. It is jointly owned by two electric utilities systems and an industrial plant, so that to all practical purposes it is really three plants under one roof—so much so that certain of the details of design are not the same throughout the plant.

It is the first large plant where all the boilers are designed for 1400 lb. pressure. Moreover, while all auxiliaries are motor-driven, no provision is made for house turbines, sufficient reliability being placed on outside power as the plant is interconnected with two huge systems (The American Gas and Electric Co. and The United Gas Improvement Co.)

The Deepwater station, planned to go into service in November, is to supply electric power to the Atlantic City Electric Co., a subsidiary of the American Gas and Electric Co.; the Delaware Power and Light Co. and the Philadelphia Electric Co., both subsidiaries of The United Gas Improvement Co., and also to supply both steam and electricity to the plant of E. I. DuPont de Nemours & Co. adjoining the station, about 1500 ft. distant.

The station is owned jointly by the American Gas and Electric Co. and The United Gas Improvement Co., but is operated and managed by the Delaware River Manufacturing Co. in the common interests of the owning companies.

Although the station is planned for an ultimate capacity of 400,000 kw., the present installation consists of a total of 118,500 kw. as follows: One 53,000-kw. unit for the American Gas & Electric Co., another 53,000-kw. unit for The United Gas Improvement Co., and one 12,500-kw. unit for the DuPont Co. All turbines operate at 1200 lb. steam pressure and are designed for steam at the throttle at 725 deg. fahr. total temperature. The two 53,000-kw. turbines are cross-compound units, each consisting of an 11,000-kw. high-pressure element and a 42,000-kw. low-pressure element, the latter operating at approximately 400 lb. pressure and exhausting into a 42,500-sq. ft. condenser designed to operate at a pressure of 1.0 in mercury absolute. Steam leaving the high-pressure elements is reheated by reheat boilers before entering the low-pressure elements.

The 12,500-kw. turbine supplying the DuPont Co. is identical in design with the 11,000-kw. high-pressure elements of the cross-compound turbines. The exhaust from this unit, however, which amounts to 530,000 lb. of steam per hr. at full load, passes directly to evaporators, which deliver 400,000 lb. of vapor per hr. at 180 lb. pressure.

This steam is delivered to the DuPont Co., but before leaving the station is superheated to 440 deg. fahr. total temperature by live-steam superheaters taking steam at 1200 lb. The condensate from the evaporators is returned to the station boiler-feed system. While the DuPont machine is arranged to operate in conjunction with the evaporators, it can be incorporated in a cross-compound unit, similar to the other two machines, should future developments in energy disposal make it desirable to do so. In such an event the space now occupied by the evaporators would be utilized by a low-pressure turbine and condenser.

These three turbines are supplied from six boilers, all operating at 1350 lb. pressure and arranged so that each turbine is served by two boilers. The cross-compound units are each served by a standard boiler and a reheat boiler, but the DuPont boilers are both standard, since no reheating of steam is required.

An extremely interesting feature of the station is the fact that two different systems of fuel preparation are provided. Pulverized coal is burned throughout, but two systems of pulverizing are used, the bin or central system and the unit system. This arrangement was adopted largely in order to determine the relative performance of the two systems under practically identical conditions. Since The United Gas Improvement Co., favored the bin system and the American Gas and Electric Co. the unit system, the facilities were so divided. The relative performance of these two systems under practically identical conditions will be regarded with great interest, since this installation provides an excellent opportunity for determining the respective merits of the two systems.

Because of the unusual operation of a power station in the interests of three different companies, the following data as to their agreements are of interest.

Under the present agreements, each of the two owning companies owns half of the capital stock of the operating company, that is, of the Delaware River Manufacturing Co. Agreement for management, operation, and maintenance, as well as existence of the operating company, may be dissolved upon two years' notice by either owner. The operating company may not sell power to other parties not covered in the agreement without the joint agreement of the owners. In the case of any misunderstanding or dispute between any of the parties concerned, such disputes are to be settled by two arbitrators appointed by the owning companies. These arbitrators select a third.

The DuPont Co. plant purchases service through the billing of steam-generation costs, proportional fixed and operating charges, etc., adjusted for equity. It receives all electrical energy produced by the turbine provided for its use, the exhaust steam of which provides process steam through evaporators. Thus the basis of charge is primary steam (adjusted) and not electrical or process-steam supply. The industrial plant may withdraw from the agreement upon specified conditions at the termination of the present contract. The agreement calls for a monthly settlement with the operating company for all energy delivered.

While the great amount of exhaust steam required by the DuPont Co. was the determining factor in adopting 1200 lb. as the boiler pressure, analyses made by Stevens & Wood, Inc., indicate the net overall results as distinctly favoring 1200 lb. as compared with a lower pressure. The estimates indicate that the total cost will exceed that for a comparable 400-lb. plant by less than $5 per kilowatt installed. This of course holds only for Deepwater, and it must not be inferred that in all cases 1200 lb. is to be preferred to 400 lb. pressure. In the case of Deepwater, the slight additional cost of the 1200-lb.-pressure plant is more than compensated for by the increased economy and is fully justified by the trend in progressive economical design. (*Power Plant Engineering*, vol. 33, no. 22, Nov. 15, 1929, pp. 1204–1214, 11 figs., *dA*)

Condensing Equipment

OWING to the lack of sufficient data and to variations in conditions under which condensers operate, it is very difficult to make an accurate comparison of the performance of the several types of surface condensers. A study was therefore undertaken by the Prime Movers Committee of the National Electric Light Association. This study of the data received by the Committee, after being corrected to a common basis of water velocity and inlet water temperature, indicates that the performance of single-pass condensers is somewhat better than that of the two-pass type, and that the performance of vertical condensers is appreciably better than that of horizontal condensers with the same number of passes. Where excessive condenser leakage resulting from tube vibration has been found, this has been effectively remedied by the installation of additional tube-support sheets and by the use of thicker tubes. Data are given in the original report in the form of extensive tables. The following details from the report are abstracted.

The average ratio of the actual to the expected heat transfer was found to be 0.835 for all two-pass installations and 0.808 for single-pass. The minimum and maximum ratios for individual single-pass condensers were 0.66 and 0.86, respectively. For individual two-pass condensers the minimum ratio was 0.63 and the maximum 1.28. Two two-pass condensers gave an average ratio of actual to expected heat transfer in excess of unity. In some cases the expected values were based upon manufacturer's guarantees, and in others upon test data obtained when the tubes were clean. Since in nearly all cases the air leakage was reasonably low, the performance with clean

tubes corresponded with the manufacturers' guarantees. The difference between actual and expected heat transfer results mainly from fouling of the condenser tubes.

Tables III and IV in the original report show performance results obtained with inlet water temperature of 35, 55, and 70 deg. fahr. These values were taken from the curves plotted for individual condensers. Data for the 35-deg. circulating-water temperature were not available in all cases. In addition to the actual heat-transfer coefficient and water velocity, the heat-transfer coefficient corrected to a water velocity of 6 ft. per sec. is shown. The average water velocity was 6.3 ft. per sec. for two-pass condensers and 6.25 ft. per sec. for single-pass condensers.

The reciprocal of the coefficient of heat transfer per unit of difference between the actual and arbitrary values of the reciprocal of the water velocity is given in the original report, as well as the average heat-transfer coefficients corrected to 6 ft. per sec. water velocity for condensers reported in Tables III and IV of the report (III being for single-pass and IV for double-pass condensers).

These average values of the heat-transfer coefficient are higher for the single-pass condensers than for two-pass condensers as shown below:

Inlet water temperature, deg. fahr.	Per cent greater heat transfer, single-pass over two-pass
35	20
55	25
70	17

This difference may be partly due to the use of smaller tube sizes in the single-pass designs. Of the eleven single-pass condensers reported, three were equipped with $^3/_4$-in. tubes, four with $^7/_8$-in. tubes, two with 1-in. tubes, and two with tubes of three different sizes ($^3/_4$, $^7/_8$, and 1 in.). The two single-pass condensers having tubes 1 in. in diameter gave a heat-transfer coefficient approximately 12 per cent lower than the average of all of the single-pass installations.

Only one two-pass condenser was equipped with tubes smaller than 1 in. in diameter. Although this unit gave a performance slightly better than the average of all two-pass installations, the performance was 8 per cent lower than that of a condenser of the same size and manufacture installed in the same station but equipped with 1-in. tubes.

As is to be expected, a greater quantity of circulating water is used with single-pass condensers than with two-pass. The quantity of water per 1000 B.t.u. of average heat transfer obtained with the circulating-water pumps operating at full capacity is 109 lb. for two-pass and 149 lb. for single-pass condensers. The average head across the circulating-water pumps when operating at full capacity is 20.5 ft. for two-pass condensers and 18.5 ft. for single-pass.

The efficiency of the circulating-water pumps has been determined from power-consumption and water-quantity data obtained with the pumps operating at full capacity. The average efficiency of the pumps used with two-pass condensers is 64 per cent as compared with 71 per cent obtained for the pumps operated with single-pass units. Owing to the difficulty of member companies accurately determining the values upon which the efficiency calculations are based, the pump efficiencies mentioned are no doubt considerably in error.

Data are given on the effect of circulating-water velocity on heat transfer, from which it would appear that the ratio of actual to expected performance is apparently no greater for condensers operated with high water velocities than for those operated at lower velocities. Figures on the power consumption of circulating pumps would indicate that although a smaller quantity of water is used in two-pass condensers, the power consumption is greater, probably on account of the higher friction drop through the condenser.

The effect of the inlet circulating-water temperature on performance is shown by comparing the values of the heat-transfer coefficient corrected to 6 ft. per sec. water velocity. For the cases where data are available over the range of temperature from 35 to 70 deg. fahr., the heat-transfer coefficient varies as follows:

AVERAGE HEAT-TRANSFER COEFFICENT IN PER CENT OF VALUE WITH 35-DEG. FAHR. INLET CIRCULATING-WATER TEMPERATURE

Inlet circulating-water temperature, deg. fahr.	55	70
Single-pass condensers	138	164
Two-pass condensers	138	178
Two-pass vertical condensers	130	186

The values of air leakage reported range from 2 to 15 cu. ft. per min., the average being approximately 5 cu. ft. per min. Only four installations, however, report leakage in excess of 5 cu. ft. per min. The air leakage reported was in nearly all cases between 2 and 6 cu. ft. per min. It is impossible to show the relation between air leakage and condenser performance since the effect of air leakage is small in comparison with the effects of other variables.

Depression of the condensate temperature reported ranges from 0 to 19 deg. fahr. The average for single-pass condensers is 4.1 deg. fahr. and for two-pass condensers 1.6 deg. fahr. The higher average depression of the single-pass condensers results from the inclusion of two condensers, with a depression appreciably higher than the average of the other nine single-pass installations. Eleven of the fifteen two-pass condensers and seven of the eleven single-pass condensers show an average depression of less than 2 deg. fahr. However, in many cases the depression is reduced as a result of the discharge of hot drains from heaters and air-ejector condensers into the main condenser hotwell. No definite relation is apparent between the depression and the air leakage. (*Condensing Equipment Serial Report of the Prime Movers Committee, 1928–1929, National Electric Light Association*, August, 1929, 35 pp., 33 figs., *gpA*)

The Siemens System of Boiler Control

THIS is a description of an electric system of boiler control as applied to traveling-grate and pulverized-coal-fired boilers. The details of the method of control cannot be reported here because of lack of space. It is claimed that the apparatus has been developed to the point where it is entirely reliable. As a visible evidence of regular operation of an automatically controlled boiler may first of all be considered the steam pressure which it maintains. Fig. 3 shows records of steam pressure in a pulverized-coal-fired boiler when the left half of the boiler was hand controlled, and the right half controlled automatically. In this case the main regulator was of a very high-sensitivity type. With automatic control of combustion the changes in load on the boiler and changes in pressure which were caused by changes in feed supply, etc., were rapidly taken care of, with the result that the variations in boiler pressure proved to be very small (as shown at the right of the figure). There was, however, a considerable disturbance in pressure around noon, i.e., at the beginning of the lunch period, when the steam load fell more than 50 per cent, but even this considerable disturbance was very quickly eliminated.

Further experience in the operation of this system of boiler control was obtained in a large central station where four boilers with traveling-grate firing had been for several months controlled by a single main regulator. Here Figs. 4 and 5 show quite a startling difference, the former representing the steam pressure of

a boiler controlled automatically and the latter that of a similar boiler with hand control. While the load fell from 28,000 to 10,000 kw. the boiler pressure remained substantially constant when controlled automatically, but varied to a marked extent when controlled by hand. A comparison of the graphs of Figs. 4 and 5 shows the advantage of automatic regulation as it affects the steam generation. Further, if the regulator be connected with both the fuel supply and air, the carbon dioxide content will be

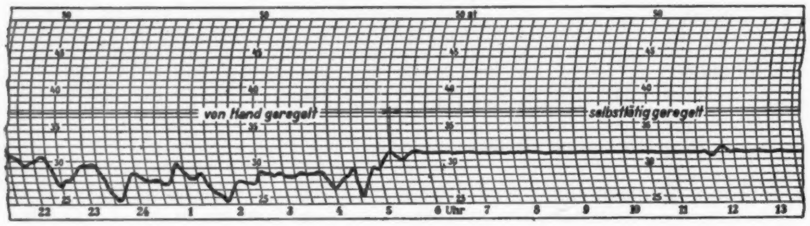
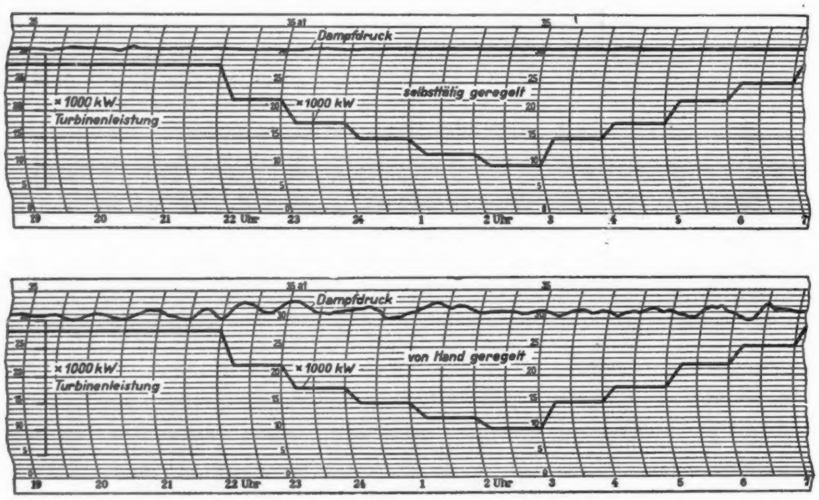


FIG. 3 GRAPH OF STEAM PRESSURE IN A PULVERIZED-COAL-FIRED BOILER WITH HAND AND AUTOMATIC CONTROL

(*Von Hand geregelt* = hand controlled; *Selbstägig geregelt* = automatically controlled.)



FIGS. 4 AND 5 GRAPHS OF BOILER PRESSURE IN A TRAVELING-GRATE BOILER

[Above—Automatically controlled; below—hand controlled. The upper line shows steam pressure (*Dampfdruck*); the lower line, output in kw. *Turbinenleistung* = turbine output. *Uhr* = hour of the day.]

held at the proper percentage by maintaining a predetermined ratio of fuel to air. The stack losses may also be maintained easily at a level which hand control permits only in exceptional cases.

It is pointed out in this connection that the full economic advantages from the installation of automatic boiler-control devices can be obtained only if all the boilers of a plant are so equipped. The installation of automatic control on a single unit may be worth while for purposes of test and demonstration, but will prove of ultimate economic advantage only in exceptional cases. Moreover, the improvement in the efficiency of the firing is to a large extent determined by the state of the plant previous to the installation of the control devices. The construction of boiler, the firing method, the fuel employed, and the dimensions of the boiler units have a very great effect on results of installation of automatic control devices. In plants well built, well supervised, and carefully operated, the installation of such devices will raise the average efficiency by at least 2 per cent. In many cases, however, the increase will be much greater. (Dr. of Engrg. Max Moeller in *Siemens Zeitschrift*, vol. 9, no. 8, August, 1929, pp. 457–463, 10 figs., *dp*)

RAILROAD ENGINEERING

Diesel-Electric-Locomotive Tests

A PARTICULARLY interesting test of the long-distance haulage capacity of the Beardmore Diesel-electric type of locomotive was carried out recently on the Buenos Aires Great Southern Railway between Plaza Constitucion Station, Buenos Aires, and Cipolletti, on the Rio Negro section, a distance, by the route transversed, of 1240 km. (775 miles). The test which was preceded by a preliminary non-stop run from Buenos Aires to Sevigne and back, a total distance of 360 km. (225 miles) resulted in the non-stop run of 775 miles being accomplished in 20 hr. 37 min., or an average of $37^1/_2$ miles an hour, the total weight moved being 159 metric tons.

The train left the terminal station of the Buenos Aires Great Southern Railway (Plaza Constitucion) at 11:08 p.m. on July 7, the traveling time for the 775 miles run being, as already mentioned, 20 hr. 37 min. The journey was accomplished without mishap either to the electrical equipment or the Diesel engine, no adjustments being necessary even at Neuquen before commencing the return trip. Although no intermediate stops were made, it was necessary to slow down at certain points for the purpose of picking up the signal staff. The average timetable speed arranged was just over 60 km. per hr., and the average speed maintained over the whole journey worked out at 60.1 km. ($37^1/_2$ miles) per hr. The fuel consumption of the trip worked out at about $^3/_4$ kg. per km., which figure is compared with an estimated consumption of 6 kg. per train kilometer for a modern oil-burning locomotive making the same journey. The weather at the time the trip was made was particularly cold, the temperature reaching below freezing point during the night.

The Diesel fuel oil used throughout the journey was obtained by local purchase, and had a specific gravity at 60 deg. fahr. of from 0.88 to 0.89, while the viscosity (Redwood No. 1 at 100 deg. fahr.) was 40 sec. and the flashpoint above 150 deg. fahr. The calorific value was approximately 19,000 B.t.u. and the water and sediment below 5 per cent. The lubricating oil (supplied by Messrs. C. C. Wakefield and Co., Ltd.) had a specific gravity at 60 deg. fahr. of 0.882, while the flashpoint (closed) was 400 deg. fahr. At 70 deg. fahr. the viscosity was 1250 sec., and at 200 deg. fahr., 62 sec., while there was a total absence of fatty oils. The following is an analysis of power consumption, etc. for the test run:

Total weight of train	159 metric tons
Total distance run	1240 km. (775 miles)
Electrical units used	2980 kw-hr.
Fuel consumed, Diesel oil	1114 liters
Specific gravity	0.085
Fuel consumed	2174 lb.
Fuel consumed per kw-hr. at the traction motors	0.729 lb.
Fuel consumed per ton-km	0.011 lb.
Watt-hours per ton-km	15

The maximum temperature of the Diesel-engine circulating water during the day, which was warm and sunny, the radiators being

on the roof without protection from the sun, was 150 deg. fahr.

The Diesels in this locomotive were built by the same concern that built the Diesels for the locomotive of the Canadian Railways Co. referred to in the December, 1929, issue of MECHANICAL ENGINEERING, p. 914. (*Gas and Oil Power*, vol. 25, no. 289, Oct. 3, 1929 p. 6, *de*)

REFRIGERATION

The Multi-Feed, Multi-Suction Evaporating System

THIS system has been installed in a large dairy in Pittsburgh. As shown in Fig. 6, the direct expansion coils 1 to 10, inclusive, are connected to the multi-feed header, the interior of which is divided into compartments 11 to 15, inclusive, by means of header partitions. The compartments in turn are connected by the eductor tubes *A*, *C*, and *E*, while liquid connectors *B*, *D*, *F*,

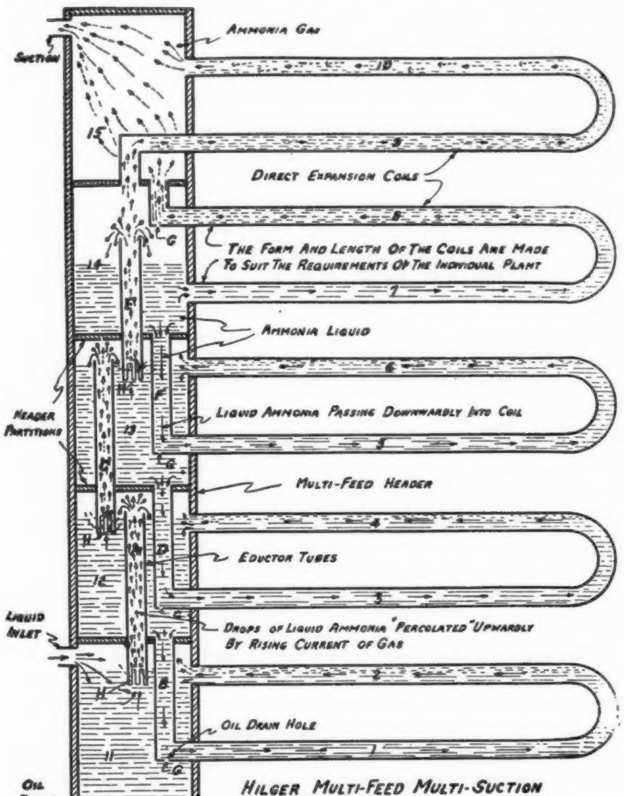


FIG. 6 DIAGRAMMATIC VIEW OF THE MULTI-FEED, MULTI-SECTION EVAPORATING SYSTEM

and *G* are provided to supply liquid ammonia to the coils at various points.

The operation of the multi-feed system may be described as follows: Liquid ammonia from the receiver and expansion valve is led into the lower chamber 11 of the header, filling the same until the liquid level reaches the lower end of the educator tube *A* at point *H*. When the liquid level reaches point *H*, the gas carries drops of liquid upward into tube *A*, and begins to fill chamber 12 of the header. After this happens the liquid begins to flow from chamber 12 into the liquid connector *B* and into pipe 1. From pipe 1 the liquid flows into pipe 2, and the gas formed in pipes 1 and 2 together with the excess recirculating liquid is discharged into chamber 11 of the header, where the liquid ammonia is again "percolated" upward through eductor tube *A* into the chamber 12 again. This liquid ammonia is now in a position again to flow down through the liquid connector *B* into the pipes 1 and 2, and this recirculates continuously. Now, when the liquid ammonia rises to the lower end *H* of eductor tube *C* the gas formed in the pipes 1 and 2 together with the flash gas produced in the lower chamber 11 travels upward through eductor tube *C*, "percolating" the fine drops of liquid ammonia upward into the chamber 13. The chamber 13 is similarly filled to the lower end of *H* of eductor tube *E*. The liquid ammonia is then flowing through the liquid connector *D* into pipes 3 and 4. It passes through pipes 3 and 4 back into the chamber 12 and then into chamber 13 again, thus completing the liquid recirculating cycle. This operation of "percolating" and liquid recirculation is repeated in every section of the evaporating unit until all pipes are supplied with a continual flow of the recirculating liquid ammonia.

Due to the construction of the header and coil, the liquid ammonia recirculates rapidly and automatically throughout every section of the coil. The liquid ammonia is continually recirculating through pipe loops 1 and 2, 3 and 4, and so on, and it is claimed that, first, static pressure due to liquid head is reduced to a minimum because of the fact that the weight of the liquid in the header is supported on the header partitions, and, second, that because of the sectionalized arrangement the friction of the flow of ammonia through the coils is reduced to a minimum. The recirculation of liquid ammonia is obtained by means of temperature difference only, and increases with increase of temperature difference between the ammonia and the medium being cooled; or, in other words, recirculation increases with the increased load on the coils.

The original article shows an assembly view of four multi-feed headers. It is stated that in the particular plant where this unit has been installed the efficiency of the ice-tank coils was improved so much that a considerable additional refrigerating load could be thrown on them for the purpose of cooling brine to be used in other parts of the plant, at the same time making more ice than has been made before. (Geo. Hilger in *Ice and Refrigeration*, vol. 77, no. 5, Nov., 1929, pp. 344–345, 2 figs., *d*)

Automatic Refrigeration at Harvard University

BRIEF description of a type of automatic refrigeration invented by Douglas K. Warner and installed in Harvard University. Ice pans are hung in rows from the ceiling and the ice frozen in them holds the surface of the pans at a constant temperature regardless of warm air flowing across them when the door is open. The system maintains the ice pans at only 0.5 deg. below freezing, thereby eliminating frost on the pans.

Mr. Warner gives a guarantee that he can maintain a temperature of 34 deg. fahr. for 48 hr. without power. The difference between the temperature of the refrigerant and that of the room is said to be only 5 deg. If this is so, the temperature of the refrigerant will not have to be so low, and will therefore use a minimum of power. This also lessens the danger of freezing the products, and allows the room temperature to be carried as low as 2 deg. above freezing. In the case of the Harvard unit, a 2-hp. motor is now being used where a 3-hp. motor was previously employed.

Brine of various densities is frozen in a pan in the top of each cabinet, and numerous copper fins extend from the bottom of each pan into the cabinets, maintaining their temperature the same as that of the frozen solution above. In this manner the desired temperature is attained, not by a fragile thermostatic control, but by varying the amount of salt put in the water. (*Cold Storage*, vol. 32, no. 379, Oct. 17, 1929, pp. 314, 1 fig., *d*)

SAFETY ENGINEERING

Industrial Medicine

INDUSTRIAL medicine does not mean merely the ability to treat fractures and burns and remove foreign bodies from various parts of the body. It requires a profound knowledge of psychology and sociology, as well as of medicine and surgery. It resembles military medicine in many respects, and calls for complicated and rapid thinking in regard to rest and recreation, amusements, the control of epidemics, and other similar lines of work, and also the keeping of accurate and complete records, with regard to the health, history, and status of every employee.

Even a physician who has had excellent training in his profession and has established a considerable reputation as a diagnostician and therapeutist, would find himself decidedly unprepared for the multifarious duties of the industrial physician or surgeon, and might not fit into the scheme of things at all.

Since this line of work bids fair to increase in importance with every passing year, and since it requires special aptitude and special training and offers very considerable rewards to the men who make a success of it, it surely will not be amiss if the younger physicians and those just entering upon the practice of medicine give industrial medicine serious consideration as a specialty to which they can profitably devote their lives. (Editorial on industrial medicine in *Clinical Medicine and Surgery*, reproduced from a copy in the News Letter, Metal Section, National Safety Council, November, 1929, *g*)

SPECIAL PROCESSES (See also Engineering Materials: Diphenyl)

Forming Glass Articles by Centrifugal Force

THIS article gives a brief review of methods of manufacture of glass articles employing centrifugal force. It states, among other things, the following:

Two inventors had enough faith in their ideas to build a first-class machine for the production of cylinders for oil cups and the like. The cylinders made on this machine are remarkable for the perfect distribution and interior finish, and the outer finish compares very favorably with that of pressed glass. One thing that impressed these experimenters was the "burning out" of seeds and blisters in the glass. Perhaps this feature could be made use of in clearing up or plaining some of the special glasses used for optical purposes.

A short list of patents on methods or devices for working glass with the help of centrifugal action is given. (Roy Swain, Engineering Dept., Macbeth-Evans Glass Co., in *Glass Industry*, vol. 10, no. 9, Sept., 1929, pp. 209–210, 2 figs., *d*)

British Die-Tool Treatments

THE original article here abstracted is entitled, "American vs. British Die-Tool Treatments," and takes for American practice that set forth in a report published by the American Society for Heat Treating.

The present abstract omits the part dealing with American practice, but presents that describing English practice. Wherever the word "report" is mentioned in what follows, it refers to the report of the American Society for Heat Treating.

A leading characteristic of the commonly used die steels in British practice, as compared with those set forth in the report under discussion, is the use of a considerable percentage of nickel, forming a nickel-chrome steel. Of the twelve varieties of steel dealt with in the report, only three contain nickel; in all the alloy steels the nickel content recommended varies from 1 per cent to 2 per cent.

As it is of considerable practical interest to compare these figures with an approved British air-hardening die steel, it should be noted that two of the grades in use have the following composition: No. 1, carbon 0.25 per cent, manganese 0.35 per cent, nickel 3.5 per cent, chromium 1 per cent. No. 2, carbon 0.35 per cent, manganese 0.55 per cent, nickel 4.25 per cent, chromium 1.5 per cent.

In these steels the rising-temperature first-change point in the range (Ac_1) takes place at about 1250 deg. fahr., and the range (Ac_3), at about 1500 deg. fahr., may be exceeded by a considerable margin, usually with marked benefit in air hardening, one outstanding feature being the great advantage presented by these steels in permitting ample working limits without the risks of overheating. Almost all the nickel steels have this characteristic. The critical range as applied to carbon steels is lowered by the presence of 3 per cent nickel to the extent of 86 deg. fahr. There is also a wider range of hardening temperatures available above the upper critical point (Ac_3) with no deterioration of properties.

In the air cooling of the above steels both the temperature and the speed of the air are arranged to yield maximum hardness upon the working surface of the die. The air should preferably be free from moisture and should be well distributed.

The carburized nickel-steel die block is still very popular in England. The following advantages are claimed for it.

In the first place, nickel steels exhibit less susceptibility to brittleness than plain carbon steels. This fact renders the carburized nickel-steel block capable of the heaviest duty in drop-hammer forging. Furthermore, the variations in the distribution of the carbon are less liable to assume independent zones than in plain carbon steels to which supplementary carburization is applied, thereby eliminating lines of demarcation and cleavage under heavy stress.

It is therefore regarded as almost exceptional to find a block of carburized 2 per cent nickel steel subject to either chipping or enfoliation—faults common in the case of unskilfully treated medium- and high-carbon steel under drop-hammer service.

For heavy-service conditions, what is known as the regenerative treatment is indispensable, and it adds but a trifle to the regular routine of carburization, which in England is conducted on the following lines:

The steel is held in the case-hardening mixture, after it is known to be red-hot throughout, for about five hours, the temperature varying according to the nature of the steel and carburant; 1562 deg. fahr. is usually considered suitable in the case of a 2 per cent nickel steel. The penetration may be increased within a given time by raising the temperature, but for the best results a reasonable temperature continued for a longer period is undoubtedly to be preferred.

The dies may be permitted to cool out in the mixture, or they may be exposed to air cooling after insuring that the temperature has fallen below 900 deg. fahr.; at this point the block may be withdrawn and at once reheated to between 1652 deg. and 1742 deg. fahr. Where the effects of oxidation upon the design on the block are to be avoided it is usual to transfer it at once to a cyanide or other bath for protection. As soon as the temperature has permeated the mass the block may be slowly cooled; for protective reasons this may be done in hot cooling oil. Of course any quench of this nature should not be sufficient to harden the surface.

The real hardening heat now follows, the temperature, prior to quenching in oil, being between 1472 deg. and 1382 deg. fahr. if water quenching is required for extra hardness. Dies of "risky" design are usually oil-quenched. In either case the operator does not cool right out in the quench, but transfers the block to the tempering furnace or bath. The drawing may progress

until a Brinell figure of 300 to 325 is attained. Under the foregoing treatment the micrographical structure of the steel is found to be a fine-grain ferrite and troostite core; the exterior is martensite, but if water-quenched, of cementite; the intermediate zone is mostly troostite, and the carbon content 1 per cent.

The original paper also discusses the temperature-raising phase in die block treatment. Except for the following statement about hardening, however, this part cannot be abstracted because of lack of space.

The hardening followed in European practice is that of slow preheating to 1500 deg. to 1550 deg. fahr., and holding at this temperature for one hour per inch of thickness. The hardening temperature is to be raised as quickly as possible to 2000–2500 deg. fahr., followed by air cooling by a dry-air blast. If the pattern upon the die is liable to damage from excessive heat, slightly lower temperatures should be used and the quench conducted in oil. It is questionable whether it is worth while to die-sink high-percentage chromium-tungsten steel in elaborate designs, owing to the difficulty of attaining effective hardness without partially fusing the finer parts of the pattern. Such work is, however, sometimes successfully treated by cyaniding. (J. W. Urquhart in *Mechanical World and Engineering Record*, vol. 86, no. 2233 and 2234, Oct. 18 and 25, 1929, pp. 373–374 and 286–287, *cp*)

STEAM ENGINEERING

Extended Steam Tables

A BRIEF abstract of this paper by Prof. H. L. Callendar, with some of the tables, was published in MECHANICAL ENGINEERING for July, 1929, pp. 527–528. The complete paper has now become available in the Proceedings of the Institution of Mechanical Engineers.

Among other things, Callendar investigated the effect of air and other impurities in the steam. Fig. 7 illustrates the procedure employed in tracing the isothermals on the *H-P* diagram and shows the first two isothermals plotted beyond the critical point at 705.2 deg. fahr. with steam of a sufficiently high and uniform degree of purity for the purposes.

The isothermal of 709.6 deg. fahr. was first plotted and a week later the isothermal of 711.5 deg. This isothermal is very similar to that of 709.6, and both lines confirm the conclusion previously drawn from experiments on the saturation volumes of water and steam in sealed tubes of quartz glass, namely, that the latent heat and the saturation lines could be traced beyond the critical point, though it was necessary to use steam of a high degree of purity and a very accurate method of measuring the total heat in order to be able to observe them. It soon became evident as the purity was improved that the small deviations from the theoretical equations were not simply due to errors of observation as at first assumed, but to defective purity of the steam corresponding roughly with variations in the air content. Further observations showed that the observed pressure is *lowered* as the impurity increases. That this happens at ordinary temperatures and pressures was known previously. No experiments had previously been made beyond the critical point, but since both v and T increase considerably while L diminishes to zero, it was easy to see that the effect of a small impurity might become very important under these conditions. The rise of the boiling point is readily estimated from some of the points of the diagram. The point 711.8 near the water saturation line happens to fall almost exactly on the isothermal of 710 deg. for the pure solvent, showing that the rise of the boiling point is here 1.8 deg. fahr. This effect cannot ordinarily be observed on the steam saturation line, where it is more marked, but is clearly shown on the diagram. The isothermal of 709.6 with air crosses the steam saturation line at 707.2, showing a rise of boiling point at this pressure amounting to 2.4 deg. fahr. These deviations diminish as the purity is improved. The condensation line for the + points at 706.2 is easily drawn by joining the two points near the saturation lines, and is much more nearly vertical than those with 0.003 per cent air. The + points at 706.8 and 707.3 agree with the 706.2 line, but are obviously still about 0.5 deg. fahr. too low as compared with the theoretical line at 707 deg. fahr. The points at 706.5 and 709.8 in the water region appear to be very nearly right; that at 713.8 is still too low, and may have been less pure than was supposed, but the possible accuracy of measurement diminishes rapidly with the latent heat.

While the observed relation between p and t at saturation is

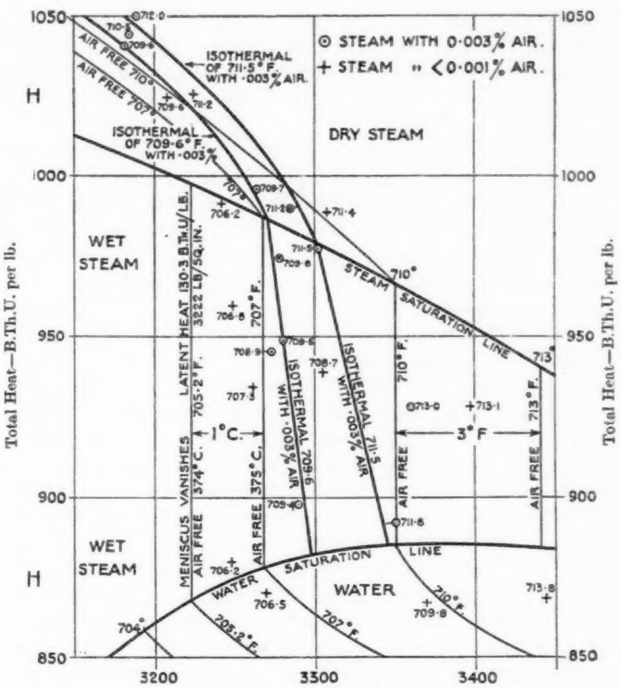


FIG. 7 EFFECT OF AIR IN STEAM BEYOND THE CRITICAL POINT

quite appreciably affected by small impurities, as explained above, it appears that the relations between H and P, represented by the two saturation lines on the *H-P* diagram, are very little, if at all, altered. In all the isothermals which have been traced, as described above, condensation appears to start when the observed value of H for the steam reaches the theoretical *H-P* saturation line for pure steam, although the pressure does not remain constant at constant temperature during condensation. Similarly, condensation appears to be complete when the value of h for water is reached on the water saturation line. This remarkable result has not previously been suspected, and could not have been detected experimentally without a very accurate method of directly measuring the total heat at any point.

Three sets of tables are given in the original paper: properties of saturated steam on a temperature basis and on a pressure basis, and properties of superheated steam. Two tables are given in each set: one in foot-pound-centigrade units, and the other in foot-pound-fahrenheit units. The latter were published in MECHANICAL ENGINEERING as previously referred to. (Prof. H. L. Callendar, F.R.S., in *Proceedings of the Institution of Mechanical Engineers*, no. 3, 1929, May, 1929, pp. 507–527, 1 fig., *eA*)

TEXTILES (See Power-Plant Engineering: An Up-to-Date British Cotton-Mill Power Plant)

THERMODYNAMICS (See Steam Engineering: Extended Steam Tables)

VARIA

Patents on Propeller-Type Hydraulic Turbines

A DECISION in the United States Court for the Middle District of Pennsylvania was issued in a litigation over the Moody patent No. 1,583,514 covering his high-speed hydraulic turbine of the propeller type. This decision is of interest both because of the subject-matter involved and also because it re-establishes certain legal principles dealing with the scope of the claims as affecting the validity of a patent and the question of infringement of claims by designs which do not read directly on the language of the claims. The decision is, of course, subject to appeal.

The opinion of the court gives first a review of the history of the patents involved, and then proceeds as follows:

"The prior art in the hydraulic turbine consisted mainly of the Francis type in America and the Jonval type in Europe, limited to low specific speed, the Nagler hydraulic turbine in America, and the Kaplan hydraulic turbine in Europe of the high-specific-speed propeller type with open runner adapted chiefly to comparatively low heads, but a feature of the Moody hydraulic turbine, as patented, has the combination of an inlet passage creating a whirling mass of water of high velocity and turning said mass from radial toward axial flow and a low-pitch axial-flow runner in which the blade area is not less than the effective area of the passage in which the runner is located. This combination of Moody of an inlet adapted to create a whirling mass of water of high velocity and a runner of the closed type is not found in the prior art. By this combination, Moody produced a hydraulic turbine which can be used where the head of water is between 30 and 60 ft., and which at any head is more stable and less liable to cavitation and disturbance than any prior machine. The novelty of this invention is further shown by the fact that Moody succeeded in doing what those who represented the prior art said could not be done: namely, the successful use of a high-speed propeller turbine of the closed-runner type under a high head of water.

"An illustration of the successful use of plaintiffs' hydraulic turbine is their successful installation at the Power Company plant in Manitoba, Canada, which operates under a head of 56 ft. Thus we have in favor of the validity of plaintiffs' patent not only the presumption arising from the issuance of the patent, Fairbanks vs. Stickney, 123 Fed. 79; Kokomo vs. Kitselman, 189 U. S. 8; Miller vs. Nagle, 151 U. S. 186; Nash Engineering Co. vs. Trane, 29 Fed. (2nd) 438; Belden vs. Gerlock, 24 Fed. (2nd) 852, but also the convincing evidence of an improvement of and an advancement over the prior art and the accomplishment of advantageous result or use of a hydraulic turbine which up to the time of Moody's disclosure, representatives of the prior art said could not be accomplished.

"From the foregoing statement of the case, it appears that plaintiffs' patent is a novel and useful improvement upon the prior art and is valid.

"The question remains whether plaintiffs' machine, as patented, has been infringed by the defendant.

"In the defendant's machine the inlet to the defendant's turbine is so shaped as to create a whirling mass of high velocity, and this is not denied by the defendant, but the defendant contends that it uses an open runner. In the defendant's runner the actual blade area is equal to or greater than the disk area, but the projected area is equal to or greater than the disk area. In the defendant's Nacoochee installation the projected vane area is 92 per cent and the actual vane area is 103 per cent of the disk area. Thus it clearly appears that the defendant's Nacoochee installation of its hydraulic turbine infringes plaintiffs' claims 65 and 67 in their patent comprising blades with an area not less than the disk area of the runner, and claim 75 covering blade area substantially equal to the disk area of the runner.

"Claims 72 and 73 describe the runner blades of paintiff's patent in this suit as overlapping so that when viewed in axial projection no open space is left between successive blades for the greater portion of the blade length. Defendant's runner does not have this overlapping relationship. There appears to be a very small open space between successive blades for the entire length of the blades so that you can see through them, but a patent covers all forms in which the invention may be copied. The drawings and specifications set forth one mode of constructing the machine described in the claims. It is presumably the best mode, but the patentee is not debarred thereby from developing his invention in other forms. 'The principle of the invention is a unit, and invariable; the modes of its embodiment in the concrete invention may be numerous and in appearance very different from each other.'—2 Robinson on patents, 485. 'The patentee having described his invention and shown its principles and claimed it in that form which most perfectly embodies it, is deemed to claim every form in which his invention may be copied.' Winans vs. Denmead, 15 Howard 330. 'An infringement takes place whenever a party avails himself of the invention of the patentee, without such variations as constitute a new discovery.' Norton vs. Jensen, 49 Fed. 859.

"The defendant by appropriating all of the elements of claims 72 and 73, even though its runner blade differs in form, cannot avoid the charge of infringement in respect to these two claims.

"In plaintiffs' claims 68 and 74, the projected blade area is not less than the disk area. As originally presented these claims described the axially projected area of the blades as being 'substantially equal' to the disk area. This was amended to 'not materially less than,' but was again objected to on the ground that the drawing disclosed blades with a projected area of more than the disk area. The claims were again amended by the patentee to read 'not less than,' and as so amended they were allowed.

"The amendments made by Moody were not made because of the state of the prior art. Nagler had stipulated that his runner blades had a projected area of not more than 80 per cent of the disk area, and Moody was free to use anything so far as the prior art was concerned which did not conflict with Nagler. The patent was not restricted by Moody to the precise form embodied therein. His preamble states:

" 'These and various other objects of my invention will become apparent on consideration of a disclosure of a limited number of specific forms in which the invention may be embodied as set forth in the following specification taken with the accompanying drawing. It will be understood that further modifications than those shown in the drawings can be made that will fall within the scope of my invention.'

"It is clear that the amendments were made to meet the objection of the Patent Examiner that the claims did not correspond with the runner as shown in the drawings, and not because of the general terms of the patent, or the prior art.

" 'Where a claim includes a specific element in a specifically limited form, where such limitation is not required by the general terms of the patent or the state of the prior art, the court may construe the claim nevertheless with a scope commensurate with the invention.' Reece vs. Globe, 61 Fed. 958; Metallic vs. Brown, 104 Fed. 343; McCormick vs. Aultman, 69 Fed. 371; Hey-

wood vs. Syracuse, 152 Fed. 453; Hillbore vs. Hale, 69 Fed. 958.

"The drawings shown in the patent do not limit the patentee to that particular construction unless the claims themselves contain such express limitation or the art is so crowded that the patent is limited to the form shown. It is clear from a study of prior art and the Nagler and Moody patents that the combination of an inlet creating a whirling mass of water of high velocity with an axial-flow runner has been covered by Nagler and Moody, Nagler preempting the open-runner field and Moody covering the closed-runner field. The defendant has sought to take advantage of the fact that the projected area of the Nagler runner blades was stipulated to be not more than 80 per cent of the disk area and the projected area of the Moody runner blades was stipulated to be not less than 100 per cent of the disk area, and had treated the ground between as open to the use of any person. Since every such runner must operate functionally either as an open runner or a runner of the closed type, it is clear that any one making the combination preempted by Nagler or Moody must infringe one or the other. The real test of infringement is that the defendant's runner functions as a runner of the closed type, although slightly differing from the Moody runner in form. Winans vs. Denmead, 15 Howard 330.

"It follows from the description of plaintiffs' and defendant's runners and the fact that the defendant's runner functions as a closed runner that the defendant has infringed plaintiffs' claims 68 and 74." (Abstracted from private copy of the Opinion of the Court, March term, 1927, no. 536, Equity, *g*)

Installment Selling

INSTALLMENT selling has greatly widened the demand for manufactured goods among people who otherwise could not have purchased the articles in question. An output of 4,500,000 automobiles in the United States in 1928, for instance, could hardly have been reached without the deferred-payment plan. It may be said on good authority that the losses of concerns extending installment credit has averaged less than 1 per cent in recent years.

Underlying the entire idea of installment selling is, indeed, a sound economic principle, namely, that productivity creates purchasing power, which statement might be called the American version of the economic doctrine first enunciated by Adam Smith—"the wealth of nations does not consist of the unconsumable riches of money, but of the consumable goods annually produced by society."

From 70 per cent to more than 90 per cent of all gas stoves, phonographs and radios, automobiles, furniture, mechanical refrigerators, pianos, washing machines, sewing machines, and vacuum cleaners are sold on the installment plan.

Total installment purchases in the United States have been estimated to amount at present to from \$5,000,000,000 to \$6,000,000,000 a year, or in terms of value only about one-seventh of the total retail sales of the year. Practically all installment purchases require a fairly substantial initial payment.

The total amount of currently outstanding installment paper is estimated at from \$2,000,000,000 to \$2,500,000,000—about half of the annual new savings of the population. (Magnus W. Alexander in a paper before the World Engineering Congress, Tokyo, Japan, Oct.-Nov., 1929)

The Transmission of Orders by Teletype

THIS article describes the apparatus developed by and used in the Delaware County Electric Co. and the Delaware Division of the Philadelphia Suburban Counties Gas and Electric Co., subsidiaries of the Philadelphia Electric Co.

The telephone-typewriter, or "teletype" as it is called, is an instrument designed for the electrical transmission of typewritten messages between two or more points equipped with sending and receiving machines. A message written on the sending machine appears simultaneously upon the receiving machine, with which it is synchronized.

Certain changes and refinements were found necessary before its introduction into the electrical and gas industry was to become a successful possibility. The service order of the utility company, it might be explained, is ruled and spaced in such a way as to accommodate information upon a dozen different angles bearing on either a meter installation or a delivery of certain merchandise. The receiving machine must necessarily marshal the data into line, each into a space corresponding to that on the service-order form of the sending operator.

There were features about the installation for the utility which were considered decidedly unique and called for exhaustive tests, running over a period of months, before a satisfactory result was obtained. As a consequence of these tests, order forms were especially designed and adapted to the teletype so that the movements of the carriage and roller of both the sending and receiving machines are absolutely identical. The installation in question is being used for the transmission of all types of service orders for both gas and electric service, including meter installations and removals, shut-off and turn-on orders, and miscellaneous service requests common to the industry. (*Electrical World*, vol. 94, no. 11, Sept. 14, 1929, pp. 511–512, *d*)

A Move to Discourage Liquor at Exhibits

THIS move was started by the American Foundrymen's Association and has been endorsed by the Association of Exhibition Managers. Its purpose is to discourage setting up entertainment in hotel rooms during conventions and exhibitions, and the wholesale dispensing of liquor. The move is said to be supported by hotel men, who claim that the breakage and damage resulting is far in excess of any profits from the sale of "set-ups," and that the damage to the reputation of the hotel is even more serious. The statements of the American Foundrymen's Association and the Foundry Equipment Manufacturers' Association place the matter on a purely general basis, asserting that such practices "detract from and tend to defeat the purposes of such conventions," and "result in excessive, unnecessary, and unwarranted expense contrary to good business ethics and practices." Nothing contained in the resolutions would indicate that this is a "dry" move as the term is generally understood. C. E. Hoyt, Executive Secretary and Manager of Exhibits of the American Foundrymen's Association, in a recent letter, says that room entertainment has grown up in much the same manner as the giving away of souvenirs. It is largely competitive, being engaged in by companies because their competitors do it, or whose representatives believe it is necessary in order to get business.

"It is our belief," he continues, "that practically all those who engage in this practice at our or any other conventions would welcome relief from it. We do not believe that the chief executives of any concern would give their representatives carte blanche expense accounts for this sort of entertainment if they were told that our joint associations disapproved and were given to understand that their competitors, as well as they, would be governed in accordance with the expressed wish of our association." (*The Iron Age*, vol. 124, no. 22, Nov. 28, 1929, p. 1457, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Test Code for Complete Steam-Electric Power Plants

Tentative Draft of a Code in the Series of Twenty-One, Formulated by the A.S.M.E. Committee on Power Test Codes

THE Main Committee on Power Test Codes takes pleasure in presenting to the members of the Society the Test Code for Complete Steam-Electric Power Plants for criticism and comment. The Individual Committee which developed this draft of the Code consists of Messrs. R. J. S. Pigott, Chairman, B. R. T. Collins, N. A. Carle, G. L. Knight, C. F. Hirshfeld, A. A. Lane, A. A. Potter, and R. W. Stovel. It is believed that in its present form this Code meets the needs of all groups which from time to time have a part in the making of acceptance tests of this type of apparatus.

In 1918 the Committee on Power Test Codes was organized by the Council of the A.S.M.E. to revise and enlarge the Power Test Codes of the Society published in 1915. This Committee consists of a Main Committee of 25 members under the Chairmanship of Fred R. Low, and 20 individual committees of specialists who are drafting codes for the various prime movers and the other auxiliary and related apparatus which constitute power-plant equipment.

Complete copies of the draft, which is published here in abstract, may be obtained from the Society's headquarters. The Individual Committee, the Main Committee, and the Society will welcome suggestions for corrections to this draft from those especially interested in the design and operation of steam power plants. These comments should be addressed to the Chairman of the Committee, care A.S.M.E., 29 West 39th Street, New York, N. Y.

Introduction

1 The Code for the Test of Complete Steam-Electric Power Plants, including plants which supply live, extraction, or exhaust steam for heating or for industrial uses, applies to tests, over reasonably long periods, for determining their overall efficiency. This Code does not cover steam power plants which develop mechanical energy for use as such, as these plants can be tested to better advantage by a combination of the "Test Code for Stationary Steam-Generating Units" and the "Test Code for Reciprocating Steam Engines." In case it is desired to test individual units of power-plant equipment during the test of the complete power plant, the necessary instructions covering the methods to be followed and the measurements to be taken can be found in the following Power Test Codes:

General Instructions
Definitions and Values
Solid Fuels
Stationary Steam-Generating Units
Reciprocating Steam Engines
Steam Turbines
Reciprocating Steam-Driven Displacement Pumps
Centrifugal and Rotary Pumps
Displacement Compressors and Blowers
Condensing Apparatus
Feedwater Heaters
Instruments and Apparatus
Speed-Responsive Governors.

Object

2 The object of the test is to obtain overall efficiency in terms of heat input and output, or heat rate per net kilowatt-hour output with or without industrial or process-steam service, and to obtain other general data which will assist in a proper interpretation of results. The heat input is the heat supplied, and the heat output is the thermal equivalent of the net station output plus the heat supplied in the industrial steam minus the heat returned in the condensate of the industrial steam.

Measurements

3 In general, all measurements for a steam-electric power-plant test should be taken with the operating instruments already installed in the power plant, together with such temporarily installed instruments as may be considered desirable or necessary by the engineer in charge of the test. In all cases instruments shall be calibrated in accordance with "Instruments and Apparatus" before starting the test, at suitable intervals during the test, and after the close of the test, in order to determine any necessary corrections. In each case in which the conditions permit, the installation of instruments shall be such as to permit the test to be of sufficient duration to reduce starting and stopping errors to a negligible amount.

4 *Fuel Weight.* The fuel weight, or, in the case of plants using natural gas, the volume, in practically all stations is regularly taken, and the regular station weighing or metering equipment shall be used. Scales must be calibrated as directed in "Instruments and Apparatus." In the case of coal or oil, the weight of fuel shall be so taken that only the fuel supplied to the station will be included. This weight of fuel is comprised of that for the station output and all its losses. Any yard shrinkage, which varies with the seasons, locality, method of fuel handling, etc., should be reported separately since it is not a direct function of the plant efficiency.

5 *Fuel Analysis.* The regular station sampling and analysis of fuel shall continue over the period of the test. Special samples shall be taken according to the "Test Code for Solid Fuels" system of sampling, and separate analyses made of the fuel. At least one special sample shall be taken every forty-eight hours, and more samples may be taken at the discretion of the engineer in charge of the test.

6 *Boiler-Feed Make-Up.* In a straight steam-electric station, in which all units exhaust to surface condensers or equivalent, the amount of boiler-feed make-up is generally so small as to have little effect on the economy of the station. However, where it is the intention to calculate losses, a record should be kept of the amount and the temperature of such make-up. If steam is supplied for industrial purposes, in addition to the electric power, an accurate record should be taken of the temperature and amount of the make-up as a check on the direct readings taken of the industrial steam and industrial-steam condensate return (if any). Where returns are received from the industrial steam supplied, the measurement of the total boiler-feed make-up is to include this quantity.

7 *Kilowatt-Hour Output.* Station meters for kilowatt or kilowatt-hour output shall be calibrated before and after the period of test. The instrument transformers shall be checked under their actual or equal burdens.

8 *Steam for Industrial Purposes.* When steam is an output of the station, the meters for measuring the steam should be properly calibrated and may be supplemented with test meters operated in series with the station meters in order that a continuous check may be made on the station meters. Additional instruments must also be available for observing temperatures and pressures to check the station instruments for these readings. The quality of the steam should also be carefully checked with an additional calorimeter, even though one is installed for normal operation of the station; or, if the steam is superheated the temperature should be taken by an accurate test thermometer. If the returns from the steam used for industrial purposes are brought back for boiler feeding, instruments should be installed in series with the station instruments for recording the temperature of these returns, and the returns should be independently weighed to check the meters used in the station for this purpose.

9 *General.* The regular station meters calibrated as mentioned above will be satisfactory for obtaining power factor, total kilowatt-hours generated, kilowatt-hours used by auxiliaries, station load, steam pressure at the boiler drum and at the prime-mover throttle, and steam temperature at the superheater outlet. In addition to the regular station meters, special test instruments shall be used for obtaining the vacuum at the prime-mover exhaust and the temperature of the steam at the throttle.

Operating Conditions

10 The operating conditions shall be as near the normal operating conditions to which the station is subjected as is practicable. The duration of the test, for accurate results, should be one month. For short tests to obtain data not requiring great accuracy, tests of one week, or of twenty-four hours' duration, may be employed. The test of twenty-four hours' duration, however, is of little value and is not acceptable for fulfilment of overall guarantees. All station records should be kept carefully during the period of the test in order that special conditions which may arise may be properly recorded. A station test should preferably be made in either the spring or the fall when, as a general rule, the available condensing water is at a temperature which permits the maintenance of the required vacuum and at the same time will require full load on the circulating pumps. No special effort shall be made to obtain a higher steam pressure or temperature at the prime-mover throttle than is obtained in normal operation.

11 Apparatus installed for test purposes must be arranged so as not to affect the performance of the station. If this cannot be done, a special test shall be made to determine the effect of removing and replacing the apparatus in question, and a proper allowance shall be made therefor. Careful record shall be kept of all losses such as these incurred in blowdowns, soot blowing, etc., even though they may be considered as part of the normal operation of the plant. During the operation of a test, the water which is removed from boilers taken off the line for cleaning should be weighed, as this will be a source of loss. It will not be acceptable in a test of a complete station to shut down completely, for the purpose of reducing the fuel consumption, boilers which normally are carried banked for emergency conditions. It is not in accord with the spirit of this test to have all the boilers put in perfect condition before the start of the test in order to bring up the efficiency, but the normal sequence of cleaning and shutting down should occur during the period of the test, as in normal operation. The normal condenser-cleaning program shall also be maintained during the test. It will be permissible to have all the prime movers in good condition before the start of the test, as the overhauling of prime movers comes infrequently and should not come in the period of the test.

Records

12 Station records on recording instruments will be the principal data in this test, but forms should be made up and observers provided for reading periodically all the special instruments and apparatus installed for the test. Readings should be taken at definite, specified times. The intervals for the twenty-four-hour test should be the same as for the twenty-four-hour boiler test (see "Test Code for Stationary Steam-Generating Units"). For durations of a week or a month, the intervals may be correspondingly lengthened. In addition to the records taken, special note should be made of abnormal occurrences, failure of apparatus, and particularly shutdowns or partial loss of load.

13 Calculations of the efficiency of the station should be begun as soon after the start of the test as a sufficient number of readings have been taken, in order to determine whether there is any obvious defect, either in observation or operation, which will make the test useless if continued.

14 *Storing and Reclaiming Coal.* The energy used in storing and reclaiming coal during the period of the test may not have any direct relation to the normal operation of the plant, but a part of it, based on kilowatt-hours per pound of coal fired, shall be included in the total kilowatt-hours used for station purposes during the test. The method of determining the kilowatt-hours per pound of coal fired as specified in the tables of test data and results given in the complete code is based on a year's figures, either actual or forecast. The total kilowatt-hours used during the test period in storing and reclaiming coal shall be subtracted from the total kilowatt-hours used for station purposes, during the test period, and to the remainder shall be added the kilowatt-hours as figured on the "as-fired" basis, Item 134 (Long Form, Table 1) or Item 48 (Short Form, Table 2).

Effect of Tetraethyl Lead on Flame and Pressure Propagation

The effect of tetraethyl lead, both in the vapor phase and thermally decomposed, on flame speeds and rate of rise of pressure following ignition, was determined for explosive mixtures of benzene, pentane, isohexane, and heptane in air. Tetraethyl lead vapor was ineffective in retarding combustion until decomposed by the burning mixture, whereas decomposed tetraethyl lead, introduced before firing the charge, retarded both flame-speed and rate of rise of pressure.

A hot surface was introduced into the bomb to secure auto-ignition of the charge ahead of the advancing flame. This auto-ignition produced an unusually high rate of rise of pressure.

Decomposed tetraethyl lead prevented or delayed the auto-ignition and retarded the resulting combustion.

High-frequency pressure waves ordinarily present in the explosions were eliminated by decreasing the number of sparks in the igniting discharge. Their effect of these waves on the combustion and on the initiation of a violent "shock wave" was determined.

The shock wave observed differs markedly from a true detonation wave. It is apparently developed only after auto-ignition of the explosive mixture ahead of the flame or after complete inflammation, and is reflected back and forth through the completely inflamed gases with the velocity of sound.—*Industrial and Engineering Chemistry*, December, 1929, p. 1261.

Engineering and Industrial Standardization

Echoes From the A.S.M.E. Annual Meeting

Centrifugal and Turbo-Compressors and Blowers. At the quarterly meeting of the A.S.M.E. Committee on Power Test Codes the secretary announced the appointment by the Council of the new committee on a Test Code for Centrifugal and Turbo-Compressors and Blowers. A. T. Brown is chairman of this new group.

Machine Tapers. Technical Committee No. 3 of the Sectional Committee on Small Tools and Machine-Tool Elements reached a tentative decision on the proposed standard taper series for machine tapers. This series is made up of three (3) tapers having 0.500 in. slope, Morse tapers Nos. 1, 2, 3, 4, and and 5, one (1) taper 1.500 in. large and with 0.623 in. slope, and ten (10) tapers having 0.75 in. slope. A new sub-group was formed to develop proposed standards for (*a*) method of measuring and gaging tapers, (*b*) tolerances for taper shanks, (*c*) dimensions for retaining key slot in socket and shank, (*d*) driving key slot in socket, and (*e*) dimensions of tang and tang slot.

Mechanical Standards Advisory Council. The Mechanical Standards Advisory Council Executive Committee held a meeting at which it was reported that 22 organizations had taken membership in the Council already, and that a considerable number of others are giving membership official consideration.

Twist Drills. Technical Committees Nos. 7 and 8 of the Sectional Committee on Small Tools and Machine-Tool Elements made definite progress toward establishing a series of standard diameters for twist drills. The proposed standard series will be distributed shortly for criticism and comment.

A.S.M.E. Standardization Committee. The A.S.M.E. Standardization Committee held its regular quarterly meeting, at which Edward J. Kearney, secretary-treasurer, Kearney and Trecker Corporation, was elected chairman. The appointment of Prof. Earle Buckingham, associate professor of engineering standards and measurement, Massachusetts Institute of Technology, as the new member of the Committee was announced.

Following this meeting a luncheon conference at the Engineer's Club was attended by forty-five chairmen of sectional and sub-committees for which the A.S.M.E. is sponsor or joint sponsor.

Small Tools and Machine-Tool Elements. A further development in the standardization of machine-tool elements was instituted at the meeting of the Sectional Committee on Small Tools and Machine-Tool Elements. Chairman Spicer was authorized to appoint a new technical committee to prepare proposals for standard dimensions of milling-machine-table widths and lengths, and the distance between T-slots. This group will be known as Technical Committee No. 15. This new sub-project is of special interest to the users who design and build fixtures and fittings for milling machines.

It was reported also that the standardization of splines and spline shafts had been assigned to new Technical Committee No. 13, of which C. W. Spicer is to be chairman.

Analysis and Presentation of Data. A Round-Table Conference on Analysis and Presentation of Data was attended by eighty members of the A.S.T.M. and the A.S.M.E. The conference was called by these two societies jointly. The objects of this conference were:

1 To show that under the new order of things where statistical concepts play an important role, we need new tools for presenting and interpreting data.

2 To call attention to the fact that new tools are available, the use of which makes a significant improvement in our interpretation of data.

3 To encourage further research in the development of new tools.

4 To formulate some plan to insure that these new tools as developed will be used effectively in applied science.

M. C. Rorty, vice-president, International Telephone and Telegraph Company, presided, and Dr. W. A. Shewhart, special engineer, Bell Telephone Laboratories, opened the discussion. Greetings were brought to the conference by Dr. E. B. Wilson, professor of vital statistics, Harvard University, and president, American Statistical Association.

Drawings and Drafting-Room Practice. This Sectional Committee discussed the five proposals on dimensions of paper and cloth, methods of indicating dimensions, lettering, layout, and line work. A subcommittee on editing was appointed, with Prof. T. E. French as chairman, to correlate and edit the various sections of the final proposed standard into a unified whole.

Lock Washers. A series of standard sizes for lock washers was approved by the Committee. This proposal is to be distributed for general criticism and comment as soon as the Committee has drafted introductory statements to accompany it.

A Building-Exits Code

A NATIONAL standard safety code for building exits aimed to cut down the annual loss of 15,000 lives by fire in the United States, has just been approved by the American Standards Association and made available for adoption by state and municipal authorities and for use by architects, engineers, and builders. The code was prepared by a technical committee of thirty representatives of safety and insurance organizations, federal government departments, state departments of labor, local fire departments, architects, engineers, and others. It represents sixteen years of study by this committee and its predecessors.

The National Fire Protection Association assumed the technical leadership in the preparation of the code under the national standardization procedure of the American Standards Association. The code contains an entire new section on theaters and other places of public assembly, and a revision and enlargement of a tentative code issued in 1927, covering safe exit provisions for schools, hospitals, department stores, factories, and other occupancies.

In the section on theaters, the code says: "The practice of allowing persons to stand near exits, however, should be discouraged if not prohibited altogether. The utilization of standing space within theaters or motion-picture-theater auditoriums should be prohibited."

The code also states that: "The line of travel to an exit door by any aisle shall be not greater than 150 ft., and if more than 100 ft. it shall have not more than one angle or turn. Not more than 20 transverse rows of seats shall be placed between cross-aisles. Not more than 10 rows of seats nor 12 ft. of rise may be placed between cross-aisles where steps are provided in the main aisles to overcome differences in level. Cross-aisles shall

be not less than 44 in. wide, unless railed away from the seats fronting thereon. If so railed, the width shall not be less than 3 ft.

Particular attention in the code is devoted to fire drills.

"In buildings where the population is of a changing character and not under discipline, for example, in hotels or in department stores, no regularly organized fire-exit drill, such as that which may be conducted in schools is possible," says the code. "In such cases the fire-exit drills must be limited to the regular employees who, however, can be thoroughly schooled in the proper procedure and can be trained to properly direct other occupants of the building in case of fire. In occupancies such as hospitals, no regularly constituted fire-exit drill is practicable. Here again, however, the regular employees can be rehearsed in the proper procedure in case of fire; such training always is advisable in all occupancies, whether or not regular fire-exit drills can be held."

In an extensive section of the code devoted to schools, school buildings of low height are recommended because of their greater safety. The code recognizes the necessity for higher buildings in cities, however, and provides accordingly. It stipulates that schools should have corridors at least 8 ft. wide, and it recommends that in elementary schools lockers should not be located in corridors.

In the part of the code devoted to department stores it is provided that no portion of any building or section shall be more than 100 ft. (along the line of travel) from the nearest exit.

Limit Gaging—Can an International System Be Established?

A NATIONAL standard system of fits has now been established, or is in course of development, in 18 countries. Under the auspices of the International Standards Association, a survey was made of the different systems with a view to investigating the possibility of ultimately unifying them into a single international system. The German national standardizing body, which is acting as the secretariat for this study, has issued an elaborate report in which the data collected are compared.

An article, "Limit Gaging—Can an International System Be Established?" was prepared by John Gaillard, member of the A.S.A. staff, and published serially in *American Machinist*, July 25, August 1, and August 15, 1929, to make the essentials of this investigation available to American engineers.

The article, in dealing with the findings of the report of the international secretariat, sets forth the basic principles of limit gaging in separate sections under the following headings: reference temperature; basic hole and basic shaft systems; unilateral and bilateral tolerances; classes and grades of fits; and selective assembly. The questions of the basic structure of a limit system, the limits and wear of gages, and the designation of fits as necessary for drawings and specifications are also discussed. The article notes in conclusion that a proposal for an international system of limits is now being drafted by a committee consisting of the delegates from five countries: Czechoslovakia, France, Germany, Sweden, and Switzerland.

Reprints are available upon request to the A. S. A. office.

List of American Standards

THE American Standards Association has just published an official list of Engineering and Industrial Standards grouped under the various engineering divisions. The number of these standards published in each group is as follows: A—Civil Engineering, 18; B—Mechanical Engineering, 30; C—Electrical Engineering, 23; D—Automotive (Automobiles and Aircraft), 3; E—Transportation, 10; G—Ferrous Metallurgy, 3; H—Non-Ferrous Metallurgy, 7; K—Chemical Industry, 8; L—Textile Industry, 1; M—Mining, 9; O—Wood Industry, 4; P—Pulp and Paper Industry, 5; and Z—Miscellaneous, 32. This list is corrected to September 1, 1929. Copies may be procured from the American Standards Association, 29 West 39th Street, New York, N. Y.

Revisions and Addenda to the Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Code.

The Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the Code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the Committee, it is the intention of the Committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type enclosed in brackets.

PROPOSED REVISIONS

PAR. U-23 REVISED:

U-23. Pressures vessels shall not be fabricated by means of fusion welding under the rules given in Pars. U-67 to U-79 except:

a Air vessels, when the diameter does not exceed 20 in., the length does not exceed 3 times the diameter, and the working pressure does not exceed 100 lb. per sq. in.

b Other vessels, under these rules, in which the circumferential joints only may be welded, when the inside diameter does not exceed 48 in., or 72 in. when at least 75 per cent of the load on a flat head is supported by tubes or through stays extending from head to head.

C WHERE THE VESSELS ARE FABRICATED IN ACCORDANCE WITH THE RECOMMENDED PROCEDURE FOR FUSION WELDING OF PRESSURE VESSELS GIVEN IN THE APPENDIX, THE LIMITING DIAMETER IN PAR. U-23*A* MAY BE TAKEN AS 60 IN. AND THE

LIMITING PRESSURE MAY BE TAKEN AT 200 LB. PER SQ. IN., PROVIDED THE TEMPERATURE DOES NOT EXCEED 250 DEG. FAHR.

Par. U-68 Revised:

U-68. WHEN WELDED IN ACCORDANCE WITH THE RECOMMENDED PROCEDURE FOR FUSION WELDING OF PRESSURE VESSELS GIVEN IN THE APPENDIX, THE STRENGTHS OF JOINTS MAY BE CALCULATED ON A MAXIMUM UNIT WORKING STRESS (S), AT RIGHT ANGLES TO THE DIRECTION OF THE JOINT, AS FOLLOWS:

FOR BUTT DOUBLE V LONGITUDINAL WELDS	8000 LB.
FOR BUTT SINGLE V GIRTH OR HEAD WELDS	6500 LB.
FOR DOUBLE FULL FILLET LAP OR GIRTH WELDS	7000 LB.
FOR SPOT OR INTERMITTENT GIRTH OR HEAD WELDS	5600 LB.

UNLESS THE PROCEDURE FOR FUSION-WELDED VESSELS GIVEN IN THE APPENDIX IS FOLLOWED IN ALL PARTICULARS [when properly welded by the fusion process] the [strength of a joint may be calculated on a maximum] unit working stress (S) AT RIGHT ANGLES TO THE DIRECTION OF THE WELD SHALL NOT EXCEED 5600 lb. per sq. in. (see Par. U-20).

Recommended Procedure for Fusion Welding of Pressure Vessels

It is the purpose of this statement to outline such a course of procedure, embracing the essentials of proper fusion welding, as will not only insure sound and safe welded construction for pressure vessels, but will also enable such results to be duplicated at any place and at any time. This procedure outline is general in character and contemplates the use of any of the established methods of fusion welding, either hand or machine, for the construction of pressure vessels. The subject-matter is presented under the following subdivisions:

I	Materials	V	Supervision
II	Design	VI	Inspection
III	Construction	VII	Testing
IV	Qualification of Welders		

I—MATERIALS

Plate for Shell, Heads, Etc. Steel plates for any part of a vessel that are subject to stress produced by internal pressure and are welded, shall be of good weldable firebox or flange quality conforming to the Specifications for Steel Plate of Flange Quality for Forge Welding, as given in Pars. S-264 to S-279, or to the Specifications for Steel Boiler Plate in Pars. S-5 to S-17 of Section II of the Code.

Material for Manholes, Nozzles, and Other Connections. Material for manholes, nozzles, and other connections which are to be joined to the shell or heads by fusion welding, shall, when forged or rolled, comply with the specifications given for shell plate and heads as to chemical and physical properties, and be of good weldable quality. Steel castings and commercial nozzles may be used only when the material has been proved to be of good weldable quality.

Filler Material. Welding wire, rods, and/or electrodes must be smooth and free from scale, rust, oil, or grease. In the hands of an experienced welder, the filler material shall demonstrate good weldability and shall flow smoothly and evenly without any unusual characteristics.

Electrodes for metal arc welding of all kinds shall conform to the American Welding Society Specifications E1A or E1B.

Welding rods for gas welding shall conform to the American Welding Society Specifications G1A.

Other welding rods, wire, and/or electrodes may be used provided they give results equal to or better than those specified in Section IV.

II—DESIGN

The design of all pressure vessels shall conform to the various requirements of the Code for Unfired Pressure Vessels. In applying the rules of this Code, however, care should be taken to proportion and so place the constituent parts of the vessel that due consideration may be given to the requirements of the welded joint. In all cases where plates of unequal thicknesses are butted, it is desirable to reduce the edge of the thicker plate in some manner so that it is approximately the same thickness as the other plate; this is an exceedingly important element in obtaining complete fusion and should be treated as one of the factors contributing to a sound and safe welded joint. Furthermore, in the design of welded vessels care should be taken to so locate the welded joint that the bending stresses that are inevitable in certain shapes of structures will not be brought directly upon the welded joint; as an instance may be cited the case of dished heads on cylindrical vessels, in which the weld should not be applied directly at the knuckle of the head. Corner welds should in general be avoided unless the plates forming the corner are properly supported independently of such welds. Lap joints should be avoided for heavy stresses or for the joining of thick plates. In general, welds in tension or shear are much to be preferred over those subjected to other forms of stress. The design of parts of cylindrical vessels other than the shell should be so controlled that satisfactory welded design is assured and that the vessel will have uniform strength throughout; this applies particularly to large outlets and manhole openings.

III—CONSTRUCTION

Preparation for Welding. The plates or sheets to be joined shall be accurately cut to size and formed. In all cases the forming shall be done by pressure and not by blows, including the edges of the plate forming longitudinal joints of cylindrical vessels.

Bars, jacks, clamps, or other appropriate tools may be used to hold the edges to be welded in line. The edges of butt joints must be so held that they will not be allowed to lap during welding.[1] For plates in excess of $^3/_4$ in. thickness, the offset must not be more than 10 per cent (maximum $^1/_4$ in.) for girth seams. Where fillet welds are used, the lapped plates shall fit closely and be kept tight together during welding.

The surfaces of the sheets or plates to be welded must be cleaned thoroughly of all scale and rust for a distance of about $^1/_2$ in. back from the welding edge. A steel-wire scratch brush may be used for removing light rust or scale, but for heavy scale, slag, and the like a grinder, chisel, air hammer, or other suitable tool should be used that will clean down to bright metal. When it is necessary to deposit metal over a previously welded surface, any scale or slag therefrom should be removed by a roughing tool, a chisel, an air chipping hammer, or other suitable means to prevent inclusion of impurities in the weld metal. In case there is grease or oil on the welding edges, it should be thoroughly cleaned with gasoline, lye, or the equivalent.

Welding Method. The application of this welding procedure is not limited to any method or process of welding or to any particular materials, but it is essential that the method or process shall be capable of effecting thorough fusion of the weld metal to the edges to be joined. There are no limitations as to the preparation of the edges to be welded except as provided in Par.

[1] Attention is called to the requirement in Par. U-71 of the Code that stipulates that the sheet on one side of the joint must not be allowed to offset from opposite sheet by more than one-quarter of their minimum thickness.

U-71 of the Code that for the longitudinal joints of cylindrical vessels, double-V-type welds must be applied. It is here pointed out that while Par. U-71 requires for double-V welds penetration half-way through from each side, a well-made single-V weld which is reinforced at its root is considered to be satisfactory. In cases when fusion at the root is irregular, the root of the weld shall be chipped out before reinforcing.

The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration.

As full and complete penetration of the weld metal through the entire thickness of the plate is essential for safety, considerable precaution must be taken to insure this result. If the welding is stopped for any reason, extra care must be taken, when restarting, to get full penetration to the bottom of the joint and thorough fusion between the weld metal and the plates and to the weld metal previously deposited.

In double-V butt welds the edges to be joined shall be so separated that the weld metal can penetrate to the root of the V.

Before welding the second side of the double-V, all scale and metal which has run through from the weld on the first side must be removed by some suitable method such as by chipping or grinding, and the rust removed from the adjacent surfaces for $^1/_2$ in. back. Any suitable means such as a round-nosed chisel may be used to remove the metal from the V, and a portable grinder to clean the scale from the plates.

When single-V joints are used, particular care must be taken in lining up and separating the edges to be joined so that complete penetration and fusion at the root of the V will be assured, for in some instances it will be impracticable to eliminate any lack of fusion by reinforcement of the opposite side—for example, on head seams of tanks less than 3 ft. in diameter and containing no manhole.

Particular care should be taken in the layout of joints in which fillet welds are used so as to make possible the fusion of the weld metal at the bottom of the fillet. Great care must also be exercised in the deposition of the weld metal so as to secure satisfactory penetration.

Reinforcement and Finish. The reinforcement of welds shall, in accordance with the requirement of Par. U-71 of the Code, be built up uniformly from the edge of the plate to the maximum at the center of the weld. Particular attention is called, however, to the importance of the provision in that rule that there shall be no valley or groove along the edge or in the center of the weld, but that the deposited metal must be fused smoothly and uniformly into the plate edge at the top of the V.[2] The finish of the welded joint must be reasonably smooth and free from irregularities, grooves, or depressions.

If a cylindrical shell shows irregularities after welding, it shall be rerolled to render it truly cylindrical, or the ends may be heated and shaped to come within the following limits:

> The edges of the plates at the seams shall not offset from each other at any point in excess of one-quarter of the thickness of the plate, except for plates in excess of $^3/_4$ in. in thickness, in which the offset must not be more than 10 per cent (maximum $^1/_8$ in.) for longitudinal seams, or 25 per cent (maximum $^1/_4$ in.) for girth seams.

If the thickness of a head to be attached to a cylindrical shell by a butt joint exceeds the shell thickness by more than 25 per cent (maximum $^1/_4$ in.), the head thickness shall be reduced.

Heads concave to pressure and plate edges at girth seams to be attached by butt joints shall be lined up with the shell as true as possible, dividing up any offsets. If these are more than permitted by the above limitation, corrections shall be made by reforming the shell or head, whichever is out of true, until the errors are within the limits specified. The sheets at head and girth seams shall be kept so spaced that they shall be separated at the point of welding enough to insure thorough penetration of the weld metal.

Heads convex to pressure shall, as prescribed in Par. U-74 of the Code, be prepared and applied with a length of flange of not less than 1 in. for shells not over 24 in. in diameter, but of not less than $1^1/_2$ in. for shells over 24 in. in diameter. It is recommended in the Code that this length of flange be made not less than 12 per cent of the diameter of the shell.

IV—QUALIFICATION TEST FOR WELDERS

The qualification test will consist of welding together in a flat position two plates of the same material and thickness as is to be used in the tank under consideration (see Fig. 1). Should the welder be required to make fillet welds, butt welds over $^5/_8$ in. thick, or welds in other positions than in the flat, he shall qualify in that class of work. If a backing strip be used in practice for single-V butt welds, it may be employed in making the test specimens. After cleaning and straightening the plates and machining the edges to be welded, they shall be clamped down and the edges of the V lined up (see Fig. 2). It is important that the edges of the V shall not lap during welding and thus prevent full penetration. To this end the plates shall be so spaced before starting the weld that, at the point of welding, there shall be a slight distance between the edges of the V.

The test plates shall be cut up as shown in Fig. 1 by the dotted lines and the two outside strips rejected because they may not be truly representative of the weld. This cutting may be done with a gas cutting torch. Pieces 1, 3, and 5 shall be machined as shown in Fig. 3. The reinforcement should be ground or machined off both sides. The last grinding or tool marks should be parallel with the length, and not at right angles to it.

The test specimens shall then be tested in a tensile testing machine to determine the ultimate strength in pounds per square inch.

The ultimate strength determined by tensile test will be the basis for the welder's rating. In order for him to qualify, the tensile-strength results should average at least 45,000 lb. per sq. in., with no one test piece giving less than 42,000 lb. If these results are not reached, the welder may be given a duplicate test. If the welder successfully passes this test, he shall be considered qualified.

The record of a welder's qualification test should contain complete information concerning the material of the plate welded, the filler metal used, the type of welding equipment, any pertinent particulars concerning its operation, and the quality of the weld not only as to completeness of fusion with the base metal but also as to completeness of penetration. Any peculiarities of the weld should also be noted such as finish and surface defects, style and amount of reinforcement, and appearance of weld on underside at bottom of V.

V—SUPERVISION AND LOCAL INSPECTION IN SHOP

The welding supervision constitutes the system of oversight and shop inspection which insures that the provisions for proper Materials (1), proper Design (2), proper Construction (3), and properly Qualified Welders (4), shall so cooperate as to give sound and safe welded construction. It is the duty of the management of the welding shop to provide such supervision and local inspection as will make sure that the requirements of the Code for Unfired Pressure Vessels and also those of this Recommended Procedure will be carried out on any welded pressure vessels to be stamped as provided for in the Code.

[2] If the reinforcement is built up so as to form a ridge with a valley or depression at the edge of the weld next to the plate, the result is a notch which causes concentration of stress and reduces the strength of the joint.

It is preferable, although not essential, that those who are charged with this supervision shall have a practical knowledge of fusion welding, particularly with the process that is employed. The supervisor shall provide and have readily accessible for purposes of record all necessary data concerning the material, designs, qualification of welders, etc. The assent to and signature upon the manufacturer's data report by the manufacturer's representative constitute a guarantee that the vessel conforms to the requirements of the Code for Unfired Pressure Vessels.

Any local inspection that may be provided in the manufacturer's shop must be arranged to function without possible interference with the work of the authorized inspector from the outside and employed under the terms of Section VI. Such local inspection would obviously be operated as a service of the manufacturer to check the employees and make sure that they are carrying out all instructions and the details of this procedure.

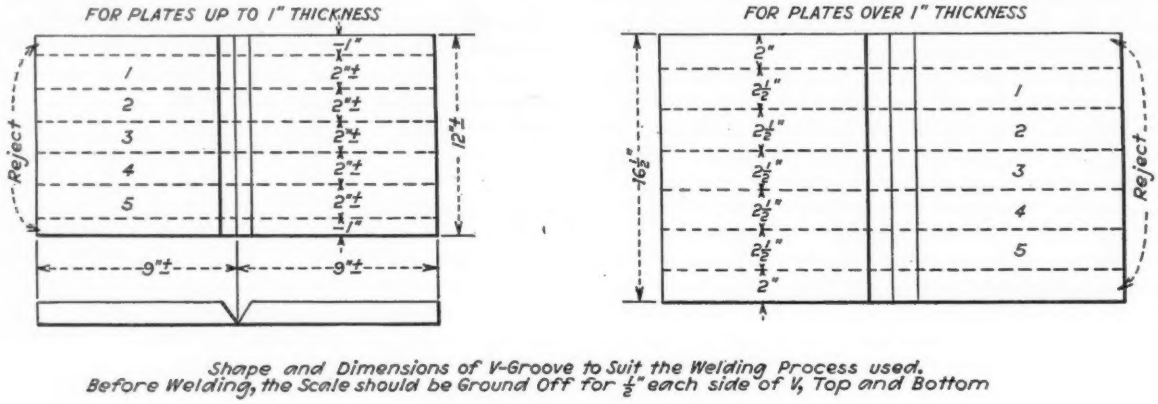


FIG. 1 QUALIFICATION TEST PLATES

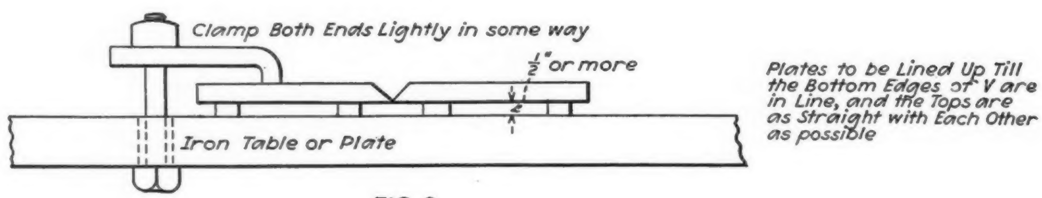


FIG. 2

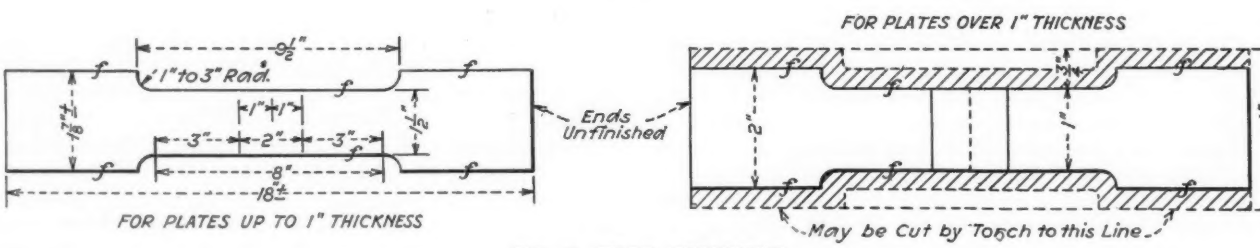


FIG. 3 TEST SPECIMENS

VI—INSPECTION

The manufacturer shall arrange for inspection of the pressure vessels during construction, as provided for in Par. U-65 of the Code. The inspector employed for this purpose shall not be in any way connected with the management of the shop performing the welding, but shall be a state or municipal inspector or an inspector regularly employed by an insurance company engaged in boiler or pressure-vessel inspection work.

It shall be the duty of the inspector to check the construction of the vessel to make sure that the provisions of this Recommended Procedure are carried out. He must arrange his inspections covering materials, design, and construction to conform to Code requirements, and the qualification of welders to meet the convenience of the supervisor or other representative of the manufacturer, and be prepared to sign the data report furnished by the manufacturer. He must direct particular attention of the manufacturer to the requirements for testing of welded vessels in Par. U-78 of the Code.

Inspection of Material. The inspector shall satisfy himself that all material used in the manufacture of a vessel is in accordance with the Code requirements, and if he desires he may secure from the manufacturer a written statement to the effect that it is, to the best of his knowledge and belief, in accordance with the Code. All parts shall be examined whenever possible before they are assembled as well as after they are applied. Material having injurious defects as referred to or defined in the Code shall be rejected.

The inspector shall see that plates are properly stamped before being used. Should the identifying marks be obliterated or plates separated into two or more parts in the process of work, he shall see that such marks are properly transferred under Code requirements.

All material shall be gaged or measured to determine whether the thickness meets with the Code requirements, due allowance being made for Code variations. During the process of manufacturing a vessel, the material shall be inspected for surface defects, cracks, blisters, pit marks, blowholes, or any other defects liable to develop in fabrication, and for excessive hammer marks. If defects are sufficient to materially impair the strength,

the vessel shall not be stamped with the Code marking. If depressions are found, careful measurement shall be made, and if by reason of the reduced thickness the plate is not weaker than where machined for holes or openings for connections and outlets, it may be accepted, provided that in no case shall a plate be accepted having a depression greater than 15 per cent of its thickness and not exceeding 4 in. in its greatest length. Plates that are found laminated shall be rejected.

All cast parts when ready for use shall be carefully examined to determine that the walls are not less than the designed thickness, free from injurious defects, and annealed as required by the Code. All lugs, brackets, nozzles, flanges, manhole frames, and other appurtenances shall fit snugly and conform to the curvature of the shell or surface to which they are attached.

After the shell is welded, the inspector shall inspect the welds from the inside and the outside of the shell and record their appearance. Before examining a weld, the outside and inside of the shell shall be struck all along the length of the weld with a hand hammer to break loose the scale. A wire brush shall also be used to clean the surfaces. Double-V welds shall be hammered the same as single-V welds.

In any case low spots in or at the sides of the weld may be filled up as in the case of pinhole repairs. If the low spots are not longer than four times the thickness of the plate, and if they do not go below the surface of the plate, they need not be repaired.

VII—TESTING

After welding has been completed and the vessel has cooled and is ready for testing, it shall be given the hydrostatic pressure test as prescribed in Pars. U-65 and U-78 of the Code. The water used for testing shall preferably be of a temperature not less than that of the surrounding atmosphere, or at least not under 70 deg. fahr.

Care shall be taken in filling the vessel to set it up with one of the outlets on top and leveled so that all of the air therein can escape when it is filled with water. A test gage shall be connected to a suitable outlet on the vessel which shall preferably read to approximately double the maximum hydrostatic pressure. The connection to the gage should be fitted with a cock or valve so as to prevent the shock of hammer testing from being communicated to the delicate gage mechanism.

The pressure shall be slowly raised until it meets with the Code requirements for the type of vessel under test, and shall be held there long enough to enable the inspector to examine all visible parts. If the tank is entirely free from leaks under these tests, it shall be accepted by the inspector, who shall certify thereto on the data report form. If leaks occur, they may be repaired in the following ways:

Pinholes, except on longitudinal seams, may be calked, filled with a plug not to exceed $^1/_4$ in., or welded by the metal-arc process without preheating, or they may be melted out and rewelded by any process, provided the metal around the pinhole is preheated to a dull red for a distance of at least 4 in. all around it. Any preheating means may be used, such as a flange fire, gas or oil burner, or a welding torch. The preheating should be done slowly, so the heat will get well back into the plate and expand it thoroughly. After welding, the tank should be reheated in the vicinity of such weld until the heat has equalized in the dull red spot, and then slowly cooled.

Pinholes in longitudinal seams must be repaired only by cutting or melting out the defect and rewelding with the above precautions in regard to preheating and reheating, except that with metallic-arc welding, preheating and reheating are not required. Cracks in welds shall only be repaired by cutting out the weld and rewelding the entire seam.

After repairs have been made, the tank shall again be tested in the regular way, and if it passes the test the inspector shall accept it. If it does not pass the test the inspector can order supplementary repairs, or if in his judgment the tank is not suitable for service he may permanently reject it.

A.S.M.E. Boiler Code Committee Work

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Commitee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and published in Mechanical Engineering.

Below are given records of the interpretations of the Committee in Cases Nos. 637–641, inclusive, as formulated at the meeting on October 25, 1929, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 637

Inquiry: Can the manufacturer of safety valves stamp thereon a size greater than the inlet and stamp the valve A.S.M.E. Standard?

Reply: It is not permissible to mark a safety valve a size greater than the nominal initial base inlet diameter required under Par. P-273*b*. This diameter must be at least equal to the inside diameter of the nominal-size pipe required for the particular pressure.

Case No. 638

Inquiry: Is it necessary, under the requirements of Par. P-317 of the Code, that check valves and stop valves be inserted between an economizer and the boiler to which it is connected, where the economizer is so arranged that there is a free flow of water or of steam and water from economizer to the boiler?

Reply: Where an economizer is connected directly to the boiler without intervening valves, it shall be considered as part of the boiler and the construction thereof should conform with Power Boiler Rules. The feed valves and check valves shall in such an arrangement be placed on the inlet of the economizer.

Case No. 639 (Annulled)

Case No. 640

Inquiry: Is it permissible to weld the flanged-in edges of the firedoor opening of a vertical tubular boiler where no staybolts are used between the furnace and outside sheet around the door opening because the furnace is of the corrugated self-supporting type?

Reply: Par. P-186 of the Code is mandatory in its requirement for staybolting or other form of support around the door-hole opening in case the flanged-in edges of the plates are welded.

The use of this form of construction without staybolting or other equivalent method of support for the sheets adjacent to the opening will therefore not meet the requirements of this paragraph.

CASE No. 641

Inquiry: Is it permissible, under the requirements of Pars. P-197 and U-38 of the Code, for manufacturers to furnish dished heads with the radius of dish 6 in. less than the nominal outside diameter of head, considering that present standard diameters starting at 30 in. and increasing in increments of 6 in. have their dishing radius the same as nominal diameter of the head?

Reply: Pars. P-195 and U-36 of the Code do not require that the dishing radius must be the same as the nominal diameter of the head, and it may be made less than this if desired.

Correspondence

Boiler-Metal Embrittlement

TO THE EDITOR:

In his paper on the above subject, published in the August issue of MECHANICAL ENGINEERING, Mr. H. F. Rech gives some interesting examples of failure of boilers due to the combined influence of water and stress. The writer is glad to note that the author has come to the conclusion that these failures are not due to embrittlement by hydrogen. However, he still retains the erroneous term "embrittlement." As the writer pointed out in discussion of two papers,[1,2] the steel in these failed boilers is not "embrittled," it is merely weakened by cracks. That the metal itself retains its ductility can readily be shown.

As also indicated in the writer's discussion of the Parr and Straub papers, it seems to him that those authors overemphasize the influence of water composition and underemphasize the influence of stress. This erroneous view has been adopted by Mr. Rech. The view seems to be well summarized in one sentence in an editorial mention of the paper in Section Two of the August issue of MECHANICAL ENGINEERING. This sentence is: "Strict attention to the character of the boiler water, however, will prevent the embrittlement of metal even when stressed." Attention to the character of the boiler water alone will not prevent the type of failure that is erroneously called "embrittlement." This type of failure is due to the combined influence of corrosion and cyclic stress, and probably never occurs unless the actual stress in some part of the boiler is higher than it should be.

At the Naval Engineering Experiment Station we have investigated for several years the effect of stress, time, and number of cycles in causing penetration of metal under corrosion or other chemical action.[3-11] This has thrown much light on the causes of boiler failures as well as many other failures of metals in service. Composition of the water is only one of several important factors that cause deterioration of metal in boilers. Other factors are stress, number of cycles, and amount of oxygen in the water. These other factors are at least as important as water composition. Some of the factors are more important.

The above-mentioned experiments indicate that the real factor of safety in an ordinary boiler is much less than has usually been supposed. Whether or not the boiler contains sodium carbonate, it will fail if the stress in regions of stress concentration is raised much above the nominal working stress, especially if there are frequent wide variations of stress in service.

Too much emphasis has been placed on the intercrystalline nature of some of the cracks found in failed boilers. Failure is due to the combined influence of stress and corrosion. Under some circumstances the cracks may be intercrystalline; under other conditions they may be transcrystalline. This means merely that the combined influence of stress and corrosion seeks the regions of least resistance to the combined attack. There is no evidence, however, that the resistance of ordinary steel to transcrystalline attack is much greater than the resistance to intercrystalline attack.

The above-mentioned experiments at the Naval Experiment Station have shown that cyclic stress accelerates corrosion pitting, and that the acceleration has an exponential relationship to the stress range. This applies to all metals in contact with water. The failure of boilers is only one example of the great influence of cyclic stress on corrosion.

D. J. MCADAM, JR.[12]

Annapolis, Md.

TO THE EDITOR:

I have read Dr. McAdam's discussion of my recent paper and agree with him that the term "embrittlement" is erroneous as the metal is not brittle. This term has been used, however, in the past and, as stated, for lack of a better term I used this phrase. I realize that Dr. McAdam has carried on a great many experiments. There is no question but what differential temperature is a big factor in metal failures. I do know, however, that where we have a great differential in temperature and the proper construction in riveted seams and our water conditions right, we do not experience any difficulty. I think I illustrated this fact very clearly in the case cited at our Jaxon Plant where we had boilers of the same design and same make operating under the same stresses with different water conditions. I also tried to bring out the point that we never experienced difficulty only at the points where the metal was stressed to or beyond the elastic limit, due to either the operating strains of the stresses set up during manufacture.

I am of the opinion that if Dr. McAdam will carry on some experiments he will find that the caustic will accelerate and be absorbed along the lines of stress, and that the time of failure will be reduced materially.

H. F. RECH.[13]

Detroit, Mich.

[1] S. W. Parr and F. G. Straub, "The Cause and Prevention of Embrittlement of Boiler Plate," Proc. Am. Soc. Test. Matls., vol. 26, part II, 1926.

[2] S. W. Parr and F. G. Straub, "Embrittlement of Boiler Plate," Proc. Am. Soc. Test. Matls., vol. 27, part II, 1927.

[3] D. J. McAdam, Jr., "Stress-Strain-Cycle Relationship and Corrosion-Fatigue of Metals," Proc. Am. Soc. Test. Matls., vol. 26, part II, 1926.

[4] Id., "Corrosion-Fatigue of Metals as Affected by Chemical Composition, Heat Treatment, and Cold Working," Trans., Am. Soc. Steel Treating, March, 1927, vol. 9, no. 3.

[5] Id., "Corrosion-Fatigue of Non-Ferrous Metals," Proc. Am. Soc. Test. Matls., vol. 27, part II, 1927.

[6] Id., "Fatigue and Corrosion-Fatigue of Metals," Proc. Int. Cong. Test. Matls., Amsterdam, Sept., 1927.

[7] Id., "Corrosion of Metals as Affected by Time and by Cyclic Stress," Technical Publication no. 58, class E, Inst. of Metals; no. 21, A.I.M.E.; issued with *Mining and Metallurgy*, February, 1928.

[8] Id., "Some Factors Involved in Corrosion and Corrosion-Fatigue of Metals," Proc. Am. Soc. Test. Matls., vol. 28, part II, 1928.

[9] Id., "Fatigue and Corrosion-Fatigue of Spring Material," Trans., A.S.M.E., vol. 51, no. 10, Jan.-Apr. 1929, paper no. APM-51-5.

[10] Id., "Corrosion of Metals as affected by Stress, Time, and Number of Cycles," Technical Publication no. 175, class E, Inst. of Metals, No. 62, A.I.M.E.; issued with *Mining and Metallurgy*, February, 1929.

[11] Id., "Corrosion of Metals Under Cyclic Stress," Am. Soc. Test. Matls., June, 1929.

[12] Metallurgist, U. S. Naval Engineering Experiment Station.

[13] Consulting Engineer, Power & Maintenance Section, Works Managers Committee, General Motors Corporation. Mem. A.S.M.E.

The Conference Table

THIS Department is intended to afford individual members of the Society an opportunity to exchange experience and information with other members. It is to be understood, however, that questions which should properly be referred to a consulting engineer will not be handled here.

Inquiries will be welcomed at Society headquarters, where they will be referred to representatives of the various Professional Divisions of the Society for consideration. Replies are solicited from all members having experience with the questions indicated. Replies should be as brief as possible. Among those who have consented to assist in this work are the following:

ARCHIBALD BLACK,
Aeronautic Division
A. L. KIMBALL, JR.,
Applied Mechanics Division
H. W. BROOKS,
Fuels Division
R. L. DAUGHERTY,
Hydraulic Division
WM. W. MACON,
Iron and Steel Division
JAMES A. HALL,
Machine-Shop Practice Division
CHARLES W. BEESE,
Management Division
G. E. HAGEMANN,
Materials Handling Division
J. L. WALSH,
National Defense Division
L. H. MORRISON,
Oil and Gas Power Division
F. M. GIBSON and W. M. KEENAN,
Power Division
W. R. ECKERT,
Petroleum Division
MARION B. RICHARDSON,
Railroad Division
WINFIELD S. HUSON,
Printing Industries Division
JAMES W. COX, JR.,
Textile Division
WM. BRAID WHITE,
Wood Industries Division

Railroad

Troubles With High Boiler Pressures

R-1 What troubles have so far been experienced with high boiler pressures on locomotives?

We have not in concrete form nor does time permit development of the necessary information which should be incorporated for round-table discussion of the problem of high-pressure boiler troubles. From the standpoint of the railway the writer would again stress the fact that the terms "higher" and "high" lack reasonable definiteness. In the absence of better subdivision, the following are suggested for consideration at this round-table discussion: (1) To and including 225 lb., normal pressures; (2) from 226 lb. to and including 600 lb., moderate pressures; and (3) 601 lb. and upward, high pressures.

There seems to be an encouraging awakening as to the economical possibilities of higher steam pressures, but the opinion is strongly entrenched that as the pressure increases, maintenance expense increases in even more rapid progression.

Experience on the Delaware & Hudson Railroad where engine No. 1112, 275 lb. boiler pressure, placed in service May 18, 1927, and engine No. 1114, 300 lb. boiler pressure, placed in service Nov. 21, 1927, have yet to have a broken staybolt renewed, would seem reasonably conclusive evidence that there are other and more important factors than that of pressure entering into the maintenance problem.

The writer is hopefully expectant, in the not too far future, if the necessary cooperation of the railways can be obtained, to develop conditions obtaining, and a possible explanation why it is not pressure but other factors that are of more serious moment. (G. S. Edmonds, Superintendent of Motive Power, The Delaware and Hudson Co.)

Miscellaneous

CO_2 for Manufacture of Refrigerant

M-9 What are the most common sources of the carbon dioxide used in the manufacture of solidified CO_2 for refrigeration purposes?

All sulphite mills using the Jenssen or Tower systems have quantities of CO_2 going to waste from the top of the towers. In a particular mill, manufacturing 100 tons of sulphite pulp per day, there are from 500 to 600 lb. of carbonic acid gas per hour going to waste. The gas is of course manufactured by passing sulphurous acid over limestone.

This is not offered as a complete answer to the question but rather to encourage further discussion that will bring out information regarding methods of treating the CO_2 gas so as to make it suitable for the use indicated, and also to learn the possibilities of marketing this product. (W. L. Ketchen, Plant Manager, British Columbia Pulp and Paper Co. Ltd., Port Alice, British Columbia.)

Questions to Which Answers Are Solicited

Bending a Heavy I-Beam

M-3 It is proposed to bend a 9-in. I-beam of heavy section to a radius of 11 ft. 3 in. What methods are recommended to accomplish this without destroying the shape of the web of the beam?

Conveying Sand Hydraulically

M-10 It is planned to convey sand from a washer to a height of 20 ft. above the washer by means of water injected at high velocity through a nozzle into a 5-in pipe. Does this arrangement seem feasible, or will the quantity of water to be disposed of offset the advantages gained by the elimination of mechanical apparatus?

Leaky Boilers Following Use of Water Softeners

P-3 A user reports leaky seams and rivets following the use of softened feedwater. What may be the cause of this and what remedies are suggested?

Causes and Remedies for Cinder Cuts in Boiler Flues of Locomotives

R-4 What are the causes and satisfactory remedies for cinder cuts in the flues of steam locomotives? They occur both inside the firebox above the firebricks at the boiler head and also in the front end or smokebox.

Developments in Long-Draft Spinning of Cotton Yarn

T-2 What are the latest developments in long-draft spinning of cotton yarn? Has any system of long-draft spinning been generally adopted in this country?

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

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George A. Stetson Appointed Editor of A.S.M.E. Publications

GEORGE A. STETSON

BEGINNING with this issue, George A. Stetson becomes editor-in-chief of MECHANICAL ENGINEERING and of the Society's Transactions.

Mr. Stetson was graduated from the Mechanical Engineering Department of Sheffield Scientific School, Yale University, in 1910. For the next three years he was connected with a prominent New England manufacturing concern, and during that time gave much of his attention to technical publicity work, the preparation of articles for the engineering press, and to the revision of a treatise dealing with heating and ventilation. In 1913 he returned to Sheffield where he became an instructor in power engineering and thermodynamics. In 1920 he was made assistant professor of mechanical engineering, which position he held until 1925, when he was appointed associate professor of heat-power engineering at New York University.

Mr. Stetson's connection with the publications of the Society dates from 1918, in which year he became editor of Transactions. He carried on this work concurrently with his educational activities until 1928, when he resigned from the faculty of New York University to become a member of the Society's editorial staff.

Possessing facility of expression and exposition, the gift of vision, a broad comprehension of the aims and purposes of the Society, and a wide acquaintance among the membership, Mr. Stetson's many friends in the organization will rejoice in his promotion to this, one of the Society's most responsible posts.

The A.S.R.E.

THE American Society of Refrigerating Engineers has recently held its 25th Annual Meeting. To this society heartiest congratulations are extended.

The A.S.R.E. was organized on December 5, 1904. Transactions were first published in 1904, but were discontinued in 1914 when the bimonthly *A.S.R.E. Journal* was issued. This in turn was superseded by the monthly *Refrigerating Engineering* in 1922. The society has sections in New York, St. Louis, Chicago, Detroit, Milwaukee, Boston, and Philadelphia, and a membership of approximately 1000.

Numerous Data Book Circulars published by the A.S.R.E. indicate the extent of its technical activities in the preparation of codes and standards and in research. These activities show not only an earnestness of attention to specific details of the profession, but also a consciousness of the importance of refrigeration in matters of public welfare and public health. The tremendous advance which refrigeration has made in recent years is a spectacular achievement of which the A.S.R.E. may be justly proud for the part its members have played in it. The refrigeration of foodstuffs in storage and in transit, such vital health and economic factors in modern life; the extension of mechanical refrigeration to domestic applications; the air conditioning of theaters, offices, and industrial buildings; the increase of scientific knowledge in the fields of insulation and properties of refrigerants; the development on a commercial scale of solid carbon dioxide for use in small refrigerated packages; and countless other improvements and inventions make an impressive list of valuable accomplishments.

Relations between the A.S.R.E. and the A.S.M.E. have always been cordial. Many names of A.S.R.E. members will be found on the membership list of the A.S.M.E. Many presidents of the A.S.R.E. have been members of the A.S.M.E.—Dr. D. S. Jacobus is a past-president of both societies. In addition to this the two societies have cooperated in standards work, and one session of their annual meetings is always a joint session. The future will bring further opportunities for cooperative effort which will be mutually welcomed.

"Buyership"

THERE is such a thing as the art of purchasing, and "buyership" is as good a word as any to describe it. The engineer's relation to the purchasing of materials and machinery is somewhat different from that of the purchasing agent's, and the two should not be confused. The purchasing agent primarily buys what he is told to get. If 5000 lb. of tenpenny nails are wanted, it is his business to get them on the best terms possible with respect to prices and delivery. He selects the source of his purchase with due consideration to various factors, such as the cost of freight, possibility of delay, reliability of the seller, etc., but tenpenny nails he must get, for he has no discretion that will permit him to substitute something else for them.

The engineer is in an entirely different position. He has today a wide variety of materials and methods from which to select. In one case his choice may lie between castings, forgings, and welded parts; in another, he may use either die castings or screw-machine products. As an alternative he may consider the employment of stampings or pressed parts. In the field of materials there are wide possibilities of selecting from a long list of ferrous and non-ferrous alloys.

Under these conditions it behooves the engineer to go a little further than just meet his technical specification and to consider very carefully the economic side of his design. If he is making but one piece, straight machine work is naturally indicated. If, on the other hand, he is planning for production running into thousands of pieces, die castings or stampings or forgings would be justified. In a general way, of course, every engineer realizes this. Where the question of "buyership" comes in is in determining, in what might be called marginal cases, what is to be done. If the number of articles to be made is neither very few nor very many thousands, a situation may easily arise where offhand one may say that it will not particularly matter whether, for example, die castings or screw-machine parts are employed. It will matter, however, if an automatic-screw-machine plant in the neighborhood is idle and hungry for new business, while the die-casting plants have big orders on hand and are running to capacity. In the matter of selection of materials it will also make a difference if, for example, an alloy-steel forged part has to be made. In that case the forging is obtained from some source, sent to the shop, machined, and then annealed. If the plant has facilities for annealing, all is well, but if the forgings are received from out of town and then have to be sent out of town again for annealing, possibly to be returned to the plant for final grinding, inspecting, and packing, and it may prove to be cheaper and more expeditious to resort to some other method of manufacture. All of the foregoing considerations are of a technical nature and deal with matters in which the final decision lies with the engineer, and a wrong decision may materially affect the matter of profit and loss. It is therefore well for the designing engineer to place himself for a moment in the position of purchasing agent or else to confer with him, and thus practice true "buyership."

Substitutes for Water as a Cooling Medium

AS A COOLING MEDIUM, water has certain important advantages such as easy availability, extremely low cost, and high heat capacity—the highest of any liquid in existence. It has also certain disadvantages, the most important of which are its high freezing point and low boiling point. The former made it necessary, for example, for automobiles to use so-called "anti-freezes" in winter, such as additions of glycerine and alcohol to water, and recently, special liquids, such as ethylene glycol, known under the trade name of Prestone. The low boiling point of water in ordinary engines restricted the temperatures of the cylinder walls, and thus brought about certain limitations of output as well as a comparatively high fuel consumption. Tests made some twelve years ago fully established the fact that if instead of using 160 to 180 deg., as the top limit of temperature for the cooling water in the jackets of an automobile engine a temperature of 212 deg. was employed, the fuel consumption of the engine for the same output would be materially decreased and a noticeably higher output from the engine become possible. This led to the development of evaporative cooling for automobile engines, which, however, for some reason has not made the progress that was at first expected.

An effort in another direction has been made recently, namely, that of employing in the jacket liquids having a higher boiling point. These tests were primarily carried out with airplane engines and are said to have given very satisfactory results. One of the advantages of this method of cooling is that the size of the radiator may be reduced, thus decreasing the parasite resistance of the plane. The radiator can be decreased in size because the loss of heat by radiation and convection increases with the increase of temperature of the liquid to be cooled. Of course, the amount of liquid handled by the radiator also increases because of the lower heat capacity of the new cooling liquids, but apparently this increase is not as great as the increase in loss of heat. There are now several liquids already available for this purpose, among which are ethylene glycol, diphenyl, and diphenyl oxide. However, not enough work has thus far been done to determine the relative qualifications of these liquids for use as cooling agents in engines.

Automatically Controlled Airplanes

THE recent flight of an airplane automatically controlled as to stability and direction by apparatus designed by Elmer A. Sperry, Past-President A.S.M.E., and Wm. A. Mayo, Chief Engineer of the Ford Motor Company, calls attention to the very important subject of automatic control of heavier-than-air aircraft. In this connection clear distinction must be made in two directions. In the first place, the control of the type used by Sperry and Mayo radically differs from such safety and stability devices as, for example, the Bramson anti-stall indicator and the Handley Page slotted wing, in that the control action is effected through a servomotor or other intermediary power device and not directly by the air forces. In the second place, distinction should be made between partial-control devices such as the Sperry-Mayo and the completely pilotless-airplane system, which latter represents merely an automatically controlled plane provided with an additional device for rising into the air and sometimes landing, with the further proviso that in times of unusual stress in the case of the Sperry-Mayo or similar systems, reliance is placed on the pilot, while the pilotless airplane has to take its own chances. The purposes of the two, at least at present, are of course entirely different, though many of the principles of construction are substantially alike. All that apparatus of the automatic-control type provides is a means of relieving the pilot from the necessity of constant attention when stable conditions of flight as to altitude and direction have been more or less established and only comparatively minor variations have to be combated in order to maintain a plane at a given altitude and direction. The program of the pilotless airplane is naturally far more ambitious.

The principle of the automatically controlled airplane is generally well known. If the control is to be for stability only, then either a gyroscope or a pendulum may be used to control through servomotors the elevator and ailerons on the plane. The gyroscope was first successfully applied by Elmer A. Sperry in 1913 in a plane which, flown by his son, the late Lawrence Sperry, won the Safety Competition in Paris. Since then others, for example, Shilovski-Cook, have also employed it for the same purpose. When it comes, however, to the control of direction, so far only the gyroscope has proved successful. The principles of its use for this purpose do not essentially differ from those of the "Metal Mike" used on ships and likewise developed by Elmer A. Sperry. A device employing the principle of the earth inductor compass in combination with a photo cell is also under development, although at this writing it is understood it has not reached the practical stage.

In all of these devices, however, a pilot is required to start the plane, fly it to the proper altitude and in the proper direction, land it at the end of the trip, and operate it in serious emergencies. As recently constructed, the stabilizer and direction controller is intended merely to relieve the pilot during long flights of the necessity of constant attention under conditions where the variations are small enough to be handled by such mechanical means as pendulum or gyroscopic control. The case of a pilotless plane is entirely different. Thus far, apparently the only field in which it can be employed is the military, particularly in two kinds of services, observation and bombing.

An observation pilotless plane would carry a photographic camera and would fly over the enemy's positions, automatically taking photographs. It would then land in a desired air field or else fly over such an air field and drop the films. The bombing pilotless plane would be directed to fly over the enemy's positions, presumably far to the rear of the fighting line, drop bombs, and either return or, more likely, be destroyed by an automatically brought-about explosion of its own. During the World War such planes were designed to bomb Berlin, but the war ended before they were sufficiently developed for use. It is further believed that pilotless airplanes might be used for the transportation of mail over great distances, e.g., from New York to London. Here the pilotless craft would rise to immense heights where winds of very high velocity prevail, so that the planes would be capable of developing speeds relative to the ground of 400 to 500 m.p.h. Even with proper facilities for flying, such speeds would be very uncomfortable for human pilots.

Such pilotless planes can be controlled by two means at least—by radio waves and by perforated tape. In the case of radio waves, the problem of interference has been essentially eliminated by the employment of so-called selectors, as illustrated by the common experience of the radio public in tuning in on a given wave. Apparatus has already been developed which can be started, stopped, or directed to the right or left by radio control, and the art of radiotelemechanics is rapidly growing, although comparatively little is said about it in print.

A very ingenious system of checking pilotless airplanes has been developed, it is said, in France. There is always a possibility that an airplane will deviate from its course because of drift. If allowed to persist, this would throw the pilotless plane off its course. To avoid this the plane is equipped with a tiny transmitting apparatus arranged to send but two or three signals. At desired intervals this apparatus sends out its signals, which are recorded, and by suitable radiogoniometric means the position and direction of flight of the pilotless plane are determined practically instantly, and if necessary the proper corrections made which will return it on its proper course.

The perforated-tape control does not attempt such refinements. The motion of the plane from the time it starts taxying on the field is controlled by apparatus which in its turn is controlled by a perforated tape in the same way that Jacquard looms are operated. This kind of a control is less certain but comparatively cheap. In testifying before the Morrow Committee on Aeronautics some years ago, one of the high officials of the Army Air Service in this country let fall a remark which would indicate that a considerable amount of work along the line of development of pilotless planes is being done by the Army Air Service at Dayton, Ohio. It is quite well known that similar work is being energetically pursued by various foreign war departments. The picture of thousands of pilotless planes raining from the skies tons of explosives and gas is not one too fantastic to pass by unheedingly.

Stock Values and Prices

THE collapse of stock prices in October and November of last year has called the attention of the entire country to the institution on Broad Street in New York where engraved certificates representing shares of ownership in various enterprises are traded in. The engineer is vitally interested in the subject, in part as an investor, but primarily because practically all enterprises in which engineers are employed are now of corporate form, and all the larger ones have their securities listed on one of the big exchanges. Capital for construction work is usually raised by selling securities to the public, and any serious restriction of the market for securities means a corresponding cutting down of construction programs, and consequently of jobs for engineers.

After every collapse of stocks, explanations are offered and advice is given for the guidance of investors and directors—until the next time. One statement that has been heard a good deal is that from now on, as a result of the crash in values, the prices of stocks will be determined by their earnings. The implication of this statement is that during the boom of the last three years something else has determined the value of stocks. It is important to learn whether earnings affect prices of stocks, and if so, how.

Any one who looks over stock-exchange quotations will find that the stock of one railroad may be quoted at several hundred dollars and that of another railroad at but thirty dollars. The same applies to steel, automobile, oil, and other stocks. Apparently, therefore, those who buy and sell stocks have some kind of a yardstick to measure their values, and even a slight familiarity with the operation of the companies whose securities are quoted would indicate that it is earnings that govern the value of stocks.

Two things, however, must be clearly remembered in this connection. In the first place, it is extremely important not to confuse earnings with dividends. A company may have very large earnings and yet for a number of years not pay dividends, putting all the earnings either into reserve funds or into plant capital. The book value of a share of U. S. Steel Corporation today is said to be in excess of $250. There was a time when the book value of the same share was variously described as "hot air, "water," and "hopes," and even harsher terms were employed at times. This enormous increase in book value could have happened in only one way, and that is by following the policy of giving the stockholders in the form of dividends only a share of the earnings, plowing the remainder back into the business. The stockholder may not for a time see any returns on capital thus withheld from dividends and put to work, for example, in the form of plant equipment, but it will ultimately be reflected in the earnings of the company and hence in the value of its securities. On the other hand, several concerns have followed the policy of generosity toward stockholders during the periods of high earnings, with the result that when harder times came they got into trouble. The now defunct Carbon Steel Company may be cited as an illustration of this procedure.

The other question—as to what earnings must be taken as a basis of valuation of securities—is much more complicated. Past earnings are always interesting, but may prove to be very misleading when used as a yardstick for measuring the values of securities. With the rapid changes in individual trends of our times, a company which might have been making splendid profits a few years ago may face receivership later. A good illustration of this is the Victor Phonograph Company. This was a very prosperous concern until the radio cut tremendously into its market. Fortunately for the company, it first developed a new, superior type of phonograph, for which a new market was discovered, and then sold out to the Radio Corporation of America. Other concerns in lines which were swept out of existence by new inventions were, however, not quite so fortunate. Then again a corporation with very small earnings may practically over night bloom into a big money maker. This is illustrated by the market history of such shares as those of the National Investors or the Texas Land Trust Company. A concern making but small profits may become a very big earner because of a change in industrial conditions. This happened, for example, to the Bethlehem Steel Company, during the war years, when its securities in three years went up from a little over $20 to nearly $500. It is therefore not the past earnings but present and future earnings which really determine the value of securities, and

this is where the trouble begins, because there is no way to determine future earnings.

What is more, facts seem to indicate that one man's guess as to the future is very nearly as good as another's. It is this matter of guesswork in the determination of the value of securities that introduces the element of speculation. In fact, "speculation" is nothing but a longer word for "guessing." Let us say that on an average five-hour day of normal trading 4,000,000 shares are bought and sold on the New York Stock Exchange. Taking the average value of a share at $100, this means a volume of transactions equivalent to $400,000,000 a day, or roughly $120,000,000,000 a year. Every transaction represents a passing of ownership of a fraction of the assets, properties, and management of a going concern, because none but going concerns of substantial value can have their securities listed on the New York Stock Exchange. While, however, there is an undoubted value in every share bought and sold on the Exchange, it must be clearly realized that the valuation of the properties forming the basis of this stupendous trading is determined by nothing better than guesses as to the future course of the industries in which these concerns are engaged, and of the individual business of each concern.

The situation with respect to prices and values on the Stock Exchange is complicated still more by the activities of the professional speculators, a subject about which engineers as a rule know comparatively little and yet which is one of very great importance to them, because, as stated above, their jobs to a large extent depend on the prices which the securities of concerns by whom they are employed bring on the market. This is a subject which may be discussed here at some future time.

John A. Stevens
1868–1929

JOHN AMOS STEVENS, consulting engineer specializing in light, heat, and power, and honorary chairman of the A.S.M.E. Boiler Code Committee, died at the age of 61 at his home in Lowell, Mass., on November 18, 1929, after a long illness.

Born in Galva, Ill., on September 16, 1868, the son of George M. and Georgeanna Ames Stevens, Mr. Stevens received his education in the public schools, the Saginaw (Michigan) High School, and the University of Michigan, which latter he attended for one year. For three years he was an apprentice machinist in the shops of Mitts & Merrill, Saginaw, and for one year an assistant tool maker with the Pere Marquette Railroad.

Mr. Stevens then turned to marine steam engineering on the Great Lakes. In 1893 he came East and entered the employ of the International Navigation Company of New York, under whom, in three years, he became first assistant engineer of the *St. Paul*, then one of the finest transatlantic liners. At the age of 27 he obtained an unlimited engineer's license for ocean steamships.

In 1896 Mr. Stevens became chief engineer of the Merrimac Manufacturing Company, of Lowell, Mass., a position which he held for 13 years. During this time he practically redesigned the steam plant at Lowell, and superintended the design and construction of the power plants of the company's southern mills.

After a three months' study of steam boilers, turbines, and condensers in Europe, Mr. Stevens resigned his position with the Merrimac Company in 1909 and opened an office as a consulting engineer. He was granted a number of patents on steam boilers, superheaters, and shock-absorbing devices.

In 1911 Mr. Stevens was appointed chairman of the Boiler Code Committee of The American Society of Mechanical Engineers, a position which he held until 1925, when he was made honorary chairman. He was a member of the original Massachusetts Board of Boiler Rules, on which he represented the "boiling-using" interests. He continued his membership on this Board for a number of years, and was active in the compilation and publication of the rules for the manufacture and inspection of stationary steam boilers in Massachusetts issued by the Board in 1909.

Mr. Stevens created a trust fund under the auspices of The American Society of Mechanical Engineers, known as the John A. Stevens Trust Fund. The principal of this fund amounts to $24,000, the income of which is to be paid annually, after 1932, to Mr. Stevens' two sons during their lives, after which it reverts to the A.S.M.E. forever to establish an award to persons who have in any year made or been responsible for an invention in engineering having to do with progress in the conservation of fuels in the generation of light, heat, and power.

JOHN A. STEVENS

During the World War Mr. Stevens was standardization engineer of the United States Shipping Board, Emergency Fleet Corporation, and as such assisted in formulating "Allowances, Tolerances and Clearances of Marine Machinery and Its Inspection." In 1916 the National Association of Cotton Manufacturers presented to Mr. Stevens its Association Medal for his paper on the "Evolution of the Steam Turbine in the Textile Industry," and for having contributed the most to the advancement of the cotton industry during the year 1917.

Mr. Stevens became a member of the A.S.M.E. in 1902, was manager from 1915 to 1918, and vice-president during the years 1918–1920. He was also a member of the American Society of Heating and Ventilating Engineers, the American Society for Testing Materials, the Society of Naval Architects and Marine Engineers, the National Association of Cotton Manufacturers, the Lowell Board of Trade, the High School Building Commission of Lowell, the Boston Chamber of Commerce, the Old Colony Club of New York, the Engineers' Club of Boston, the Yorick Club of Lowell, and the Vesper Country Club of Tyngsboro, Mass.

Mr. Stevens was a loyal member of the A.S.M.E. Notwithstanding the immense amount of work he did as chairman of the Boiler Code Committee, he felt that the Society was such a great benefit to him that he owed a debt to the organization rather than that it owed anything to him. His creation of the trust fund shows the high esteem in which he held the Society.

When the work of the Boiler Code Committee was started it was viewed by many with suspicion. Mr. Stevens worked on unflinchingly in spite of aspersions which were cast by some on the activities of his Committee, and won out through steadfastness of purpose, impartiality, and an honesty of effort which was apparent to all. He was a pillar of strength in the early days of the Boiler Code Committee, and was the master builder of the present firm structure which will serve as a living monument to perpetuate his endeavors.

Mr. Stevens was married at Saginaw, Michigan, October 7, 1896, to Luella E. Holland. His wife and two sons, Holland A. and Richard A., survive him.

The A.S.M.E. Fiftieth Annual Meeting

Impressions of Convention Celebrating Half a Century of Society History, 25 Years of Local Sections Activities, and a Decade of Professional Divisions Achievement

FIFTY years of Society history—25 years of Local Sections activity—10 years of Professional Divisions achievement—these are the significant milestones that mark the 1929 Annual Meeting of the A.S.M.E. Commencing with a meeting of Local Sections delegates on Sunday, December 1, the program was charged with important gatherings of a technical and social nature without interruption, morning, afternoon, and evening, until Friday night. Even with this long period of events it was impossible to schedule committee meetings, technical sessions, and excursions without the interference of many kindred interests, and with the Eighth National Exposition of Power and Mechanical Engineering in progress at the Grand Central Palace and meetings of the American Society of Refrigerating Engineers, the Power Transmission Association, and the Taylor Society, the decision as to what to take in and what regretfully to omit was a singularly hard one.

Official figures showed that 2215 persons registered during the week of the meeting.

If cold statistics can indicate the extent of the activities of a crowded week, it may be of interest to contemplate the following. Fifty-nine technical papers were read at 27 sessions, and 13 reports were presented. Forty-four committee meetings were scheduled on the program in addition to numerous unscheduled ones, and 19 luncheons and dinners were listed. Beyond this, there were 2 codes on the program, 5 safety talks, 2 lectures, 2 symposiums, 14 excursions, and 14 college reunions. The Council met twice, the Local Sections delegates six times, the Student Branch delegates once, and the Society in business session once. In addition to these activities for the members, the ladies were provided with a special program of excursions and social events.

Charles Piez — President 1930

The American Society of Mechanical Engineers

Perhaps the most unusual and certainly the most regrettable feature of the occasion, was the absence of President Elmer A. Sperry and Secretary Calvin W. Rice, who had attended the World Engineering Congress in Tokyo, Japan, and were on the Pacific Ocean at the time of the meeting. Many other well-known members of the Society were also missed at this year's gathering for the same reason. Inasmuch as this unfortunate coincidence of the dates of these two important meetings of engineers could not be avoided, the customary address of the President, such an important feature of President's Night, had to be omitted. In the absence of the President, Edward A. Muller, Vice-President, represented him at the Council meetings and public functions of the Society. President-Elect Charles Piez, Chairman of the Board, Link Belt Co., Chicago, Ill., took office and presided at the Friday meeting of the Council.

The Technical Sessions

The papers delivered at the technical sessions of the Annual Meeting are the result of careful planning by the Professional Divisions, the Meetings and Program Committee of the Society, and various committees whose activities have reached a stage where important contributions are available. Through the efforts of these agencies the authors and subjects are chosen, and the manuscripts are received sufficiently in advance of the date of the meeting so that preprints are generally available for study and for the preparation of written discussion. So varied are the subjects, so extensive the list of papers, and so voluminous the discussion of them, that space will not permit covering them in this brief review. They form, to be sure, the *pièce de resistance* of the Annual Meeting; but their value far exceeds that of the benefits derived by this presentation to the minority of the Society's members who are present at their delivery. The Transactions of the Society will provide a permanent record of them, and their reprinting by the technical press of this and other countries will increase their usefulness.

One feature of the mechanics of this year's meeting is worthy of comment. Heretofore the Meetings and Program Committee had provided stenographers at all sessions so that a record of oral discussion might be available for the Transactions. Experience has proved that this service, expensive a luxury as it is, is unnecessary, and that the subsequent editorial expense involved in putting the imperfect transcript into intelligible form can be eliminated. Under the present plan a record of discussers' names is kept by the chairman of every session, and letters are sent immediately upon the close of the meeting requesting that the oral discussion be submitted in writing for purposes of publication. The plan was first tried at the Knoxville meeting, and was continued with success at Salt Lake City, Rochester, and Akron. Not only has the discussion finally obtained been of better quality, but the absence of the stenographer has, in many cases, given freer range to oral discussion and placed many discussers more at ease. Thus those actually in attendance frequently have the benefit of informally

presented information which those who give it are unwilling to have published. The net result of the change has been fully justified.

To single out from the many papers two which were in the nature of a novelty for an engineering meeting—papers which probably will not be available in printed form—attention is called to the one by J. E. Hannum, Editor, The Engineering Index Service, on "The Value of Engineering Periodical Literature," and that by Harrison W. Craver, Director, Engineering Societies Library, on "What the Engineering Societies Library Does for Engineers." These papers, devoted to the subject of the use of engineering literature, were designed to stimulate the interest and imagination of engineers in the valuable resources which the engineering profession has in its current and accumulated literature. It is not to the credit of engineers that their methods of investigation make less use of their literature than do those of the sciences and the humanities. Librarians recognize and comment on this peculiarity of the profession. The fault probably is one of early training and the inadequacy of technical libraries. The Society, however, is engaged in a notable endeavor to increase the usefulness of engineering literature and to develop its resources beyond the limits already reached by others. The Library and the Index are elements of this development.

The presentation of Mr. Hannum's paper, which described the Engineering Index Service, precipitated a lively discussion centered around the cost of the Service, and particularly the cost of the Index Annual, questions involving so many elements that a thorough understanding and evaluation of them is not easy. A resolution was finally passed asking the Council to take steps to reduce the cost of the Index Annual to members. The resolution, presented to the Council at its Friday meeting, was referred to the Publication Committee, which has been considering this question continuously ever since the reorganization of the Index. The great interest displayed in the Index and the suggestions made by the members of the Society and its Local Sections are gratefully appreciated by the Publications Committee in its pioneering task of developing a new and tremendously valuable professional activity.

The Professional Divisions

Ten years ago the Professional Divisions of the Society were established. It was hoped at that time to counteract a tendency, which had gained considerable headway, for individual groups of the Society's members, irked at what they considered inattention to their interests in specific questions, to break away and form smaller societies devoted to specialized engineering subjects. Such a dissipation of activities brings with it a weakening of the powerful group action which can be exercised by a large single organization, and it is gratifying to state that this movement has been checked by the noteworthy achievements of the Professional Divisions. Reviewing its ten years of history, the Standing Committee on Professional Divisions reported to Council its belief in the effectiveness of its program for broadening the scope of the activities and interests of the Society, its continuous efforts at cooperation with sister institutions, and its hope that some of these may some day be persuaded to merge their interests with those of the A.S.M.E. It requested and received from the Council an endorsement of its policy, and an expression of that body's interest and support.

The major portion of the present issue of Mechanical Engineering is devoted to the Progress Reports of the Professional Divisions which were presented at the Annual Meeting. Following a precedent established by the first president of the Society, Robert Henry Thurston, who set himself the task in his inaugural and presidential addresses of informing the Society of progress in mechanical engineering, the Professional Divisions have made these reports a feature of recent Annual Meetings. The reports form a valuable résumé of the technical status of the profession, and no engineer should neglect reading them. They are authoritative and suggestive.

The Technical Committees

The Annual Meeting, as usual, provided an opportunity for the Society's technical committees to hold sessions and hearings. There were 37 of these committee meetings throughout the week. On Wednesday there was a luncheon by the Standards Committee for the chairmen of the sectional committees and sub-committees of which the Society is sponsor or joint sponsor. Forty-three committee representatives were present, the Society being sponsor for 27 standards projects involving more than 106 committees and sub-committees. On Thursday a dinner was given by the Research Committee to the chairmen of the special research and survey committees of the Professional Division. Discussion at this gathering centered around the general policy of the Research Committee, the financing of research projects, and the advantages and limitations of cooperative research. The spirit of good-fellowship which was engendered by these gatherings gave to all those attending them an impressive realization of the great extent of the Society's technical committee activities and an interest in the work which others were doing on other committees.

A round-table conference on the analysis and presentation of data, sponsored by the A.S.T.M. and the A.S.M.E., at which many engineers and scientists interested in the application of statistical methods to engineering problems were present, provoked a long and enthusiastic discussion. As a result of it, a resolution was passed to the effect that the American Statistical Association, the American Mathematical Association, the A.S. T.M., and the A.S.M.E. appoint representatives to serve on a joint committee for the development of statistical applications in engineering.

The Local Sections

This year marked the twenty-fifth anniversary of the first Local Section of the A.S.M.E., founded at Milwaukee in 1904. Since that time, with the formation of other similar chapters, the conference of the Local Sections delegates has become an increasingly important feature of the Annual Meeting. This year there were 66 representatives present from the 71 Sections. The conferences began on Sunday, when the chairman of the Society's standing committees outlined the work for which they are responsible. In the evening the nominating committee was selected.

On Tuesday the chief subject for discussion was the licensing of engineers. Many views were expressed on this vexing problem, and both those in favor of licensing and those opposed to it voted for a resolution to the Council to the effect that a committee on registration be appointed to cooperate with similar committees of the other founder societies, the Committee on the Economic Status of Engineers, and others interested, to coordinate the efforts of the Local Sections and to draft a uniform licensing bill.

Student Branches

There were 46 delegates from the 96 student branches of the A.S.M.E. at the Annual Meeting. In all, 125 students attended the Conference of Student Branch Delegates on Wednesday afternoon which followed a luncheon of the delegates with members of the Council at which 137 were present. President Piez spoke at the luncheon. At the conference, at which Dean A. A. Potter, of Purdue, chairman of the Committee on Relations with Colleges, presided, three addresses were delivered. Dr. A. A. Adler, consulting engineer, of New York, and chairman of the Metropolitan Section, spoke on "Possibilities in the Applications

of Engineering to Plant Economy in Industrial Plants." W. A. Hanley, chief engineer of the Eli Lilly & Co., Indianapolis, Ind., and Manager of the Society, told "What Is Ahead of the Engineering Graduate." Dean L. A. Scipio, of Roberts College, Constantinople, Turkey, spoke on "Engineering in the Near East."

Just as the benefits of going to college lie as much in the experiences of human contacts as they do in the knowledge gained from books and study, so the value of membership in the A.S.M.E. is largely increased by the associations which are formed and renewed at the meetings of the Society. The Annual Meeting is looked upon by an ever-growing group of members as an experience never to be missed. Here, at least once in the year, the leaders of the profession are to be found together. Old friendships can be renewed, new ones formed. The inspiration which comes from contact with others with similar problems and interests is stimulation for further endeavor. A casual survey of the animated scenes of the foyer of the Engineering Societies Building during one of these meetings, or of the lounge of the Engineers' Club, is convincing evidence of the less tangible benefits of these annual gatherings. Those who have never had the privilege of attending an annual meeting and who must rely upon a published account of it should plan not to let another one go by without making an effort to experience it.

For the success of the many features which, taken together, made up this busy week of social and technical gatherings and excursions, much thoughtful planning and hard work had to be done. To those who assisted in these tasks the grateful appreciation of those benefited was obvious in the general spirit of the meeting and in the comments on it that were heard. In spite of the great number of the members of the Society and the large attendance at the meeting, a surprisingly large percentage made some personal contribution to it. Authors and discussers of papers, committeemen, officers of the Society, and representatives of the Local Sections and Student Branches formed a vast company of interested workers whose enthusiasm and zeal were responsible for the successful achievements which come through whole-hearted cooperation.

Book Reviews and Library Notes

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the United Engineering Society as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Fluid Dynamics for Aircraft Designers

FUNDAMENTALS OF FLUID DYNAMICS FOR AIRCRAFT DESIGNERS. By Max M. Munk, Ronald Press Co., New York, 1929. Cloth, 6 × 9 in., 198 pp., diagrams, $8.

REVIEWED BY W. F. GERHARDT[1]

AERONAUTICAL engineers have long felt the need for a volume which would give them such essentials of aerodynamic theory as were really applicable to design problems. Dr. Munk's experience as a pupil of Dr. Prandtl, and as an independent investigator, fits him very well for this task, which he has essayed in the above-titled book.

The first chapter of the work deals with the basic principles of hydrodynamics, laying particular stress upon the idea of a potential flow. Dr. Munk gives a very interesting physical conception of the velocity potential. He supposes it to be the impulsive pressure, analogous to the impulse of a hammer blow, which starts the fluid from rest to the condition being studied in a certain time interval. Another valuable concept in this chapter is the idea of apparent mass, or the mass of fluid which is given this impulsive pressure.

Chapter II deals with the application of hydrodynamic theory to the airship hull, an attempt of primary interest to the lighter-than-air engineer. An interesting development is the derivation of the formula for the unstable moment acting on the airplane hull when flying at an angle of attack, one condition of which is flight in a circular path. Dr. Munk shows that the stresses caused by gusts are larger than those caused by maneuvering. In order to approach the problem of the wing section, Dr. Munk discusses in Chapter III the potential flow about the straight line. To do this he combines the effect of the transverse flow and the circulation flow. This latter, as is well known to aeronautical engineers, has been a necessary assumption in hydrodynamic theory to develop equations for lift of airfoils. One very interesting conclusion Dr. Munk draws in this chapter is that the apparent mass of the straight line is the mass of the fluid displaced by a circle with the straight line as its diameter.

With these elementary considerations Dr. Munk proceeds in Chapter IV to give the theory of the wing section itself. He starts with Kutta's assumption, namely, that circulation is such as to cause the winds to leave the section exactly at its thin trailing edge, in other words, the wings act as a device forcing the air to leave the wing flowing in a particular direction. He shows that the properties of the wing can be computed from the mean camber of the wing itself, and that this applies as well to broken as to smooth surfaces. From these assumptions he computes both lift and moment. In this chapter Dr. Munk also takes up the theory of multiplane wing sec-

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tions, and shows they are calculated upon the same general principles. Most important among the conclusions is again one about the apparent mass of a multiplane structure, which is the circle, as for the monoplane, plus the included area between the two lines.

With these fundamental assumptions, Dr. Munk proceeds to outline the theory of the complete wings in Chapter VI. He shows that it is necessary to take into account the effect of the wing itself upon the airflow about it, or the self-induced angle of attack. This self-induced angle of attack changes the induced drag for any given lift, as well as the angle of attack at which that lift is produced. He also shows the minimum induced drag which occurs when the vertical component of the velocity is equal over the entire wing span.

In Chapter VI Dr. Munk takes up some of the important principles of propeller theory. He shows, for example, how easy it is to calculate the fundamental quantities such as its effective pitch, average slipstream velocity, thrust, and efficiency by use of this theory. The formula for efficiency in function of thrust, velocity, and diameter is particularly useful to the designing engineer in determining whether a given propeller has sufficient diameter to work efficiently.

In order to complete the aerodynamic treatment, Dr. Munk presents several advanced subjects in Chapter VII. Among these are the fundamental concepts of vortices. He points out the interesting examples of the Karman vortices which occur behind any body. The staggered position of these vortices can be easily calculated. One of the most interesting parts of this chapter is the presentation of the correction of wind-tunnel observations for the finite diameter and area of the tunnel itself, and its effect upon the observed induced resistance.

Dr. Munk completes the discussion of aerodynamic theory by giving the fundamentals of air friction on the basis of the true character of the friction drag, which is proportional to the velocity instead of the velocity squared. He shows that two flows are similar only when the product known as the Reynolds number is constant.

The book is concluded by a brief résumé of the measurements which are used to determine the coefficients in the previously discussed equations, or otherwise determine the properties of aerodynamic bodies. Dr. Munk describes the interesting method of free-flight testing a dirigible for drag, which is necessary because of the unsatisfactoriness of the wind tunnel. It might also be pointed out that the same thing really holds true of airplane models. The only really satisfactory method of determining the aerodynamic characteristics of the airplane (provided it is built, of course) is to calculate them from the double-sawtooth method of flight tests which were developed at Wright Field.

Dr. Munk shows the fundamental advantages of the polar diagram now used universally for the presentation of wing characteristics. He also shows the check which the wind tunnel has made upon the effect of the variation of aspect ratio upon the angle of attack and induced resistance of airplane wings.

The problems at the end of each chapter are the most useful part of the book. If the engineer works through these examples he will undoubtedly have a good grasp of the most important of the practical applications of aerodynamic theory to aircraft.

Books Received in the Library

AUTOMORPHIC FUNCTIONS. By Lester R. Ford. McGraw-Hill Book Co., New York, 1929. Cloth, 333 pp., diagrams 6 × 9 in., $4.50.

With the exception of an out-of-print booklet by the same author, this is the only work in English on its subject. Linear transformations and Fuchsian groups are treated in the first chapters, after which the properties of automorphic functions and the Poincaré theta series are developed. The elementary and the elliptical functions are then presented, after which conformal mapping, uniformization, and differential functions are discussed. A good bibliography is included.

COMMENT UTILISER AU MIEUX COURROIES DE TRANSMISSION. By Henri Guillon. Second edition. Dunod, Paris, 1929. Paper, 6 × 9 in., 79 pp., illus., diagram, 10.40 fr.

A brief manual for users of belting, on its proper use. The choice of belts, proper sizes and speeds, installation, tension, and maintenance are discussed.

DIE DEUTSCHEN GEWINDETOLERANZEN. By G. Berndt. Julius Springer, Berlin, 1929. Paper, 7 × 10 in., 179 pp., diagram, 16.50 r.m.

Discusses the evolution of the standardization of screw threads in Germany from the beginnings to the present time. Dr. Berndt's book, while complete in itself, supplements his earlier books on the subject, and will interest all students of tolerances in threads.

ENGINEERING MECHANICS. By William Brooke and Hugh B. Wilcox. Ginn & Co., Boston, 1929. (Engineering Series.) Cloth, 6 × 9 in., 320 pp., $3.20.

A concise course in fundamental principles, intended for students of engineering with some knowledge of the calculus. Covers statics, kinematics, and dynamics. Many problems are provided.

INDUSTRIAL ACCOUNTING. Control of Industry Through Costs. By Thomas Henry Sanders. McGraw-Hill Book Co., New York, 1929. Cloth, 6 × 8 in., 371 pp., forms, $4.

The innovations in Professor Sanders' discussion of accounting are the extensive use of case material and the concentration of attention upon the objectives of cost accounting rather than upon the mechanics of cost gathering. The book seeks to conform to the modern tendency to curtail the volume of the routine gathering of figures, and, while maintaining the current flow of essential control figures, to have the cost department free to investigate any matters of special interest at any time.

INTRODUCTION TO PHYSICAL OPTICS. By John Kellock Robertson. D. Van Nostrand Co., New York, 1929. (University Physics Series.) 422 pp., plates, diagrs., tables, 9 × 6 in., cloth, $4.

Aims to provide a comprehensive introduction to the subject which will be neither elementary nor advanced, but will lay a thorough foundation for subsequent work. Starting with a thorough discussion of wave motion and its light ramifications, the author later introduces the quantum theory, and, finally, considers briefly the problems now being studied by leading workers in optics.

LOKI: THE LIFE OF CHARLES PROTEUS STEINMETZ. By Jonathan Norton Leonard. Cloth, 291 pp., illus., portraits, $2.75.

An interesting popular account of Steinmetz's life and his connection with the General Electric Co., in which his personality, rather than his scientific achievements, is emphasized.

MACHINE DESIGN. By P. H. Hyland and J. B. Kommers. McGraw-Hill Book Co., New York, 1929. Cloth, 6 × 9 in., 448 pp., illus., diagrams, tables, $4.

Covers the course given by the authors at the University of Wisconsin. While no claim is made for originality of subject matter, the arrangement, treatment, and choice of matter are new in certain respects. The fundamental principles are presented, with an analysis of only a few applications. Kinematics

is incorporated as an integral part of machine design, a plan that obviates, in the opinion of the authors, any need for a separate text on it.

Manuel Pratique de Soudure Autogène. By R. Granjon and P. Rosenberg. Second edition. Dunod, Paris, 1929. Paper, 6 × 9 in., 410 pp., illus., 33.70 fr.

This handbook of welding practice has been very popular for years in France and has also appeared in an English translation. Apparatus for autogenous welding, methods, and their application to steel, iron, copper, brass, lead, aluminum, etc., are described in detail. This edition is revised, enlarged, and brought up to date.

Manufacture of Chilled Iron Rolls. By Archibald Allison. Isaac Pitman & Sons, New York, 1929. Cloth, 6 × 9 in., 190 pp., illus., diagram, tables, $2.50.

This description of practice in manufacturing chilled rolls for rolling-mills is apparently the only work on that subject. The author writes from personal experience, discussing furnaces, materials, methods of melting and casting, tests, results in service, etc., upon the basis of extended experiments.

Mechanics of the Gyroscope. By Richard F. Deimel. Macmillan Company, New York, 1929. Cloth, 6 × 9 in., 192 pp., illus., diagrams, tables, $4.

A comprehensive discussion of the dynamics of rotation, intended for engineers. The physical and mathematical principles are briefly reviewed in three introductory chapters, after which seven chapters are devoted to rotational phenomena and the behavior of typical gyroscopic apparatus, such as compasses and stabilizers. Physical, rather than structural, features are emphasized.

Modern Aviation Engines. By Major Victor W. Pagé. Norman W. Henley Publishing Co., New York, 1929. Cloth, 6 × 9 in., illus., diagrams, tables, 2 vols. $9.

Major Pagé has brought together a vast amount of practical information in these two volumes, which are intended chiefly for those occupied with the maintenance and repair of aviation engines. The work includes detailed descriptions of practically every engine of any importance, with instructions for their care and repair, and also explains the theoretical principles involved in internal-combustion engines. Good diagrams and illustrations are used profusely. A valuable reference book for practical men.

Oil Engine Power Plant Handbook, 1929. Fifth edition. National Trade Journals, Inc., New York, 1929. Cloth, 8 × 11 in., 288 pp., illus., $5.

A collection of practical articles on the operation of Diesel engines; on air filtration, oil purification, cooling towers, and other plant accessories; and on the uses and economics of Diesel engines. Contains also brief descriptions and illustrations of the engines actively sold in America.

Outline of Metallurgical Practice. By Carle R. Hayward. D. Van Nostrand Co., New York, 1929. Cloth, 6 × 9 in., 612 pp., illus., diagrams, tables, $7.50.

Aims to give, within a moderate size, a concise account of modern methods of extracting and refining the common metals, and of their sources, uses, and important alloys. Intended for use as a quick reference book, and to assist beginning students by giving them a rapid survey of current practice which will guide their thinking during the study of more elaborate works. Supplementary readings are suggested throughout. The author has succeeded admirably in his intention.

Psychology and Industrial Efficiency. By Harold Ernest Burtt. D. Appleton & Co., New York, 1929. Cloth, 5 × 8 in., 395 pp., tables, $3.

Aims to give the business man a fairly comprehensive survey of the application of psychology to the problems of promoting greater efficiency and happiness on the part of employees. Methods of training, the selection of methods of work, the elimination of unnecessary fatigue, alleviation of monotony, and similar topics are discussed.

Pumpen und Druckwasseranlagen. By Rudolf Vogdt. Walter de Gruyter & Co., Berlin, 1929. Cloth, 4 × 6 in., 155 pp., illus., diagrams, tables, 1.50 r.m.

A concise text on pumps and pumping machinery. Describes the various types and gives data on capacities, uses, etc.

La Rectification des Pieces Mécaniques. By Henri Guénard. Dunod, Paris, 1929. Paper, 7 × 10 in., 250 pp., illus., diagrams, tables, 57.10 fr.

Discusses the finishing of machine parts by grinding. The various factors that affect the choice of methods and machines are examined, the adaptability of grinding to various kinds of work is shown, and the advantages of the method brought forward. Cylindrical, internal, surface and centerless grinders are discussed.

Science and Thought in the Fifteenth Century. By Lynn Thorndike. Columbia University Press, New York, 1929. Cloth, 6 × 9 in., 387 pp., facsimiles, $4.75.

Professor Thorndike throws interesting light on this neglected century, concerning which he has collected, largely from manuscript and unpublished materials, much that tends to modify our usual conceptions of thought and science at that time. An introductory chapter on western science in the fourteenth and fifteenth centuries is followed by special studies of medicine and law, surgery and medicine, astronomy and mathematics, speculative and natural philosophy. The illustrations are from little-known manuscripts.

Twenty-Five Years of Flying. By Harry Harper. Hutchinson & Co., London, 1929. Cloth, 6 × 9 in., 292 pp., illus., portraits, 12s. 6d.

The author has been air correspondent of the London *Daily Mail* since 1906, and has been an eye-witness of many historic flights. His reminiscences give an informal personal record of such feats as Blériot's crossing of the English Channel, the first aviation meeting at Rheims, the London to Manchester race, and many others. The illustrations are numerous and attractive.

Turbocompressori, Soffianti e Ventilatori. By Mario Medici. Ulrico Hoepli, Milan, 1930. Paper, 7 × 10 in., 635 pp., illus., diagrams, 48 lire.

A general treatise on the design, construction, and use of these machines. Theoretical principles, structural elements, and the calculation of output are discussed in a practical manner from the point of view of the designer.

Zeitstudie und Betriebsüberwachung im Arbeitsschaubild. By Walther Poppelreuter. R. Oldenbourg, Munich and Berlin, 1929. Paper, 7 × 10 in., 86 pp., illus., diagrams, 5 r.m.

For twelve years Professor Poppelreuter of Bonn University has been engaged in the investigation of time study and production control. The final results of his work are now presented in systematic form for application in the industries.

The book describes the graphic method of time study developed by the author and explains its advantages over the ordinary stop-watch method. The varieties of work-recording clocks are described and their application to production control explained. The organization of production-control departments is discussed.

Synopses of A.S.M.E. Transactions Papers

THE papers abstracted on this and following pages appear in the current issues of the Aeronautical Engineering and Management sections of A.S.M.E. Transactions. These sections have been sent to all who registered in the similarly named Divisions. Other sections are in the course of preparation and will be announced when completed, in later issues of "Mechanical Engineering."

AERONAUTICAL ENGINEERING PAPERS

THE PRODUCTION AND USES OF HELIUM GAS. By R. R. Bottoms. [Paper No. AER-51-20]

The author, after discussing the origin and occurrence of helium in natural-gas deposits, presents an estimate of the quantity available. He then describes in detail processes for separating the gas from the other gases with which it is associated, and for purifying and liquefying it. Following this he deals briefly with the questions of storage and transportation. In conclusion he enumerates the remarkable physical properties of helium, discusses its use for the inflation of airships, both pure and in a non-inflammable mixture with 20 per cent of hydrogen, and then gives estimates of the cost of helium storage, transportation, and purification facilities at an airship terminal designed to care for four ships.

RECENT DEVELOPMENTS IN AIRCRAFT INSTRUMENTS. By W. G. Brombacher. [Paper No. AER-51-21]

Aircraft instruments are separated into four groups by the author: (1) for the power plant, (2) for speed, (3) for altitude, and (4) for navigation. General performance requirements are outlined, and testing equipment and procedure used at the Bureau of Standards are described. Among operating problems the author considers instrument-board vibration as most serious. The variation in temperature to which aircraft instruments are subjected causes a severe lubrication problem.

Standard dimensions for some of the instruments have been adopted. This makes these instruments interchangeable on the instrument board, and this is considered an outstanding achievement.

THE APPLICATION OF THE PRINCIPLE OF LEAST WORK TO THE PRIMARY STRESS CALCULATIONS OF SPACE FRAMEWORKS. By C. P. Burgess. [Paper No. AER-51-22]

A structure similar to the framework of a rigid airship is analyzed by three approximate methods commonly applied to such structures, and also by the mathematically exact method of least work. It is shown that the approximate methods may be very considerably in error. A short-cut method of least work, giving very satisfactory results, is described and applied to the structure.

COMPARISON OF REINFORCED-SHELL AND STEEL-TUBE FUSELAGE CONSTRUCTION. By W. C. Cumming. [Paper No. AER-51-23]

The author of this paper analyzes stresses in the reinforced-shell and steel-type fuselage of an airplane, and tells how various parts were constructed. Four types of construction were considered, and the reinforced-shell type resulted in a weight saving of 2 per cent.

PROBLEMS IN FLYING. By J. H. Doolittle. [Paper No. AER-51-24]

In this paper the author discusses many things that are now receiving attention to make flying safer. More and better airports are needed, and a low landing speed is essential. More attention is being given to airplane construction. The cockpit should be strong to protect the pilot in case of a crash, and there should be sufficient material between the pilot and ground to absorb the shock.

Work being done by the Weather Bureau in notifying pilots of weather conditions along the route is of great value. More frequent points for giving information will add to the service. Recent developments provide a satisfactory instrument for measuring altitude. More improvements are needed in the compass for blind flying. Flying in fog makes it necessary to direct pilots to landing ports, and to make it possible to land without seeing the ground. Much work is being done to solve these problems.

AIR NAVIGATION. By George R. Fairlamb, Jr. [Paper No. AER-51-25]

In this paper the author discusses developments in air sextants and in celo-navigation methods, as well as the kind of navigational knowledge and the minimum amount thereof which is required by aviators and overland commercial pilots.

Instrumental aids and methods have reached a state of development that make air navigation almost as exact in skilful hands as marine navigation, and, the author believes, in any case sufficiently exact. The radio beacon is undoubtedly the outstanding development and improved methods and sextants are next, while many small but vitally important details such as air maps, charts, watches, etc., have been developed to fill a much-needed gap. It is but necessary, the author states, to use the equipment now available and refinement into something better must inevitably follow.

RECENT DEVELOPMENTS IN AIR TRANSPORT. By P. G. Johnson. [Paper No. AER-51-26]

The author, after pointing out that there are 21,000 miles of established airways and 1600 airports in the United States, discusses the recent rapid growth of air-mindedness on the part of the public. As an index of this he estimates that 12,000 planes will be built in 1929 as against 622 in 1919, which latter were mostly military craft. He predicts greatly increased employment of planes for mail transportation, their speedy adoption for handling express matter, and their very general use for passenger travel.

THE RAILROADS AND PASSENGER AIR TRANSPORT. By C. E. McCullough. [Paper No. AER-51-27]

The author discusses the linking up of rail and air transport, and outlines the arrangements made by the Pennsylvania Railroad for a coordinated ocean-to-ocean passenger service in which the trip is made in two days instead of four and a half.

INSTALLING AND SERVICING AIRCRAFT INSTRUMENTS. By John D. Peace, Jr. [Paper No. AER-51-28]

Careful installation of instruments in airplanes is most essential in order that they function properly, and remain free from trouble. The author describes details of installation that have proved satisfactory for the principal types, and points out certain things that should be avoided.

Service work on instruments is divided into two classes: periodic overhauling and inspection, and adjustments done at service stations. Engineering service to the airplane builder is considered a very important part of the instrument manufacturer's duties, as it insures proper installation of the product.

SOME AEROLOGICAL PRINCIPLES APPLYING TO AIRSHIP DESIGN AND OPERATION. By F. W. Reichelderfer. [Paper No. AER-51-29]

In this paper the author discusses some of the problems of wind structure and of vertical air currents. Data are presented on local wind fluctuations of great frequency, on less frequent, widespread wind shifts, and on local vertical air movements. The discussion is not primarily of strong winds and gales as a navigational problem affecting cruising radius, but of those properties of wind structure which may be obstacles to air navigation because of the excessive forces which they may exert on airship structures.

THE SELECTION OF AN AIRPLANE ENGINE. By Lt.-Comdr. J. M. Shoemaker. [Paper No. AER-51-30]

The author states that the commonly accepted fundamental requirements of an aircraft engine are: minimum weight per horsepower; maximum dependability, durability, and economy; minimum cost; and maximum ease of maintenance. He discusses the relative importance of these requirements, from the point of view of the airplane designer, in the power plants of various types of airplanes, and adds to them another requirement, namely, the consideration of an airplane engine as an integral part of an airplane.

METHODS USED IN TRAINING *PILOTS* FOR COMMERCIAL FLYING. [Paper No. AER-51-31]

A group of three short papers discussing modern flight-training courses and advanced methods used at flying schools. The authors of these papers, Messrs. Clarence M. Young, Tex Rankin, and Oliver L. Parks, advocate use of more systematic methods for training pilots. Longer courses at flying schools with better and more uniform flight instruction will help materially for schools to discharge their duty to the aeronautical industry and to the flying public.

Greater safety in the operation of aircraft and a reduction of accidents are results that are being sought. More instruction and more varied experience for pilots before they enter the industry will do much to lessen the hazards of flying. Increased stabilization of the industry will come from providing a definite, satisfactory source of pilots and thus assure the public that satisfactory facilities are available for flight training.

MANAGEMENT PAPERS

THE SYNCHRONIZATION OF SALES AND PRODUCTION. By Howard M. Hubbard. [Paper No. MAN-51-9]

Our prosperity, both agricultural and industrial, depends to a large extent upon the ability to export surplus production. Severe competition has developed from both domestic and foreign products and the rehabilitation of European industry will only serve to make the situation more acute. The persistence of a hand-to-mouth buying policy, and the development of the style factor, are other examples of the new economic era.

The American executive has realized that the methods of yesterday are unsuited to the problems of today, with the result that a new technique is being developed which visualizes business as a coordinated and well-balanced whole. In the majority of cases, this coordination revolves about some kind of a budget. Operating schedules are based upon forecasts prepared by the sales department, which in turn presumably has made its plans upon careful market studies. It is thus possible to prepare a financial budget well in advance of operations and to estimate the effectiveness of the proposed program.

The author gives some specific illustrations of the new method as applied in an organization producing a variety of products in scattered plants.

INDUSTRY SPECIFIES ITS SCHOOL TRAINING NEEDS. By Virgil M. Palmer. [Paper No. MAN-51-10]

This paper describes a cooperative educational experiment being carried on by the industries of Rochester, N. Y., and the Rochester Mechanics Institute. It covers conditions leading to a survey by industry of its educational training needs, the appointment of a committee for this purpose, and the resulting detailed recommendations.

It was found that while educational requirements for major executives and for the great base of industrial common labor are now fairly well covered by educational institutions, there is an important intermediate field in which are the junior line and staff executives, which as yet has not been adequately covered.

Specifications expressed in terms of the qualities desired in the Institute's graduates were formulated, together with detailed recommendations covering training methods and course content which in the judgment of Rochester industries would best meet these specifications.

Industry's obligation in training the cooperative student within the factory is acknowledged, and recommendations are outlined to make the Institute most effective in its service to Rochester industries and to lead to the closest possible cooperation.

CONTROLLING THE MANUFACTURE OF PARTS ON ORDER AND FOR STOCK BY THE GANTT PROGRESS CHART. By David B. Porter. [Paper No. MAN-51-11]

This paper deals with two special applications of the Gantt progress chart in controlling production. The first shows the plan for the manufacture and assembly of parts on an order, and the progress of work in accordance with the plan. The arrangement of parts on this chart follows the natural order in the assembly of the product. The proper relationship of parts to each other and to the whole is made visible by a system of marginal indentations. This makes it possible to show by one line for each part the amount of stock on hand and in process, and the amount of time ahead or behind schedule. It also shows the time of starting work on each operation without the use of additional bars, thus condensing the chart.

The second chart is constructed essentially like the first one, but is designed for the case where manufacturing for stock is already in progress; that is, parts are being made both continuously and intermittently for continuous assembly at a uniform rate. This chart is designed to show the current condition of stores and parts in process, and the amount of time behind or ahead of schedule for each part and assembly. The method for laying out the chart is fully explained.

The function of such charts is to bring in advance to the attention of the executive those things which require action, and thereby eliminate the necessity of following up after delays have occurred. The charts measure the progress made on the manufacturing program, and in so doing they also serve as measures of executive ability.

NEW DYNAMIC DEVICE FOR SCHEDULING BY THE GANTT CHART PRINCIPLE. By Eugene Szepesi. [Paper No. MAN-51-12]

The direct presentation of magnitudes and relations in economic conditions, as originated by Gantt, is used as a foundation of the Szepesi method, and the management engineer is given a mechanical development of this graphic method that is flexible and interchangeable as developed in the dynamic graphic control instrument.

NOTE: Those who have not registered in the A.S.M.E. Aeronautics and Management Divisions whose papers are abstracted on this and the previous page, and who desire copies of any of these papers, may obtain them by using the form given below.

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THE ENGINEERING INDEX SERVICE furnishes to its subscribers a Weekly Card Index of references to the periodical literature of the world covering every phase of engineering activity, including Aeronautic, Chemical, Civil, Electrical, Management, Mechanical, Mining and Metallurgical, Naval and Marine, Railway, etc. Of the many items of particular interest to mechanical engineers a few are selected for presentation each month in this section of "Mechanical Engineering." In operating The Engineering Index Service, The American Society of Mechanical Engineers makes available the information contained in some 1700 technical publications received by the Engineering Societies Library (New York), thus bringing the great resources of that library to the entire engineering profession. At the end of the year all references issued by the Service are published in book form, this annual volume being known as The Engineering Index.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

AERODYNAMICS

Theory. The Theory of Aerodynamics, H. Leavy. Aircraft Eng. (Lond.), vol. 1, no. 4, June, 1929, pp. 121–124. Survey of problems in aerodynamics still awaiting solution on mathematical lines; fundamental equations governing motion of viscous fluid; analogy with elastic structures; importance of Reynolds' number; dimensional theory; Stanton's classic experiments; direct attacks on equations of motion slightly disturbed from steady state has yielded nothing but disappointment; no relative motion; boundary conditions; Von Karman's method. Summary of paper presented before Math. Assn.

AIR COMPRESSORS

Design. Design for Volume Change Differentiates Compressors from Blowers, S. A. Moss. Power, vol. 70, no. 15, Oct. 8, 1929, pp. 564–565, 2 figs. Scientific distinction between blower and compressor is that compressor is definitely designed to take account of appreciable change of volume when air is passing through machine whereas blower takes care of constant volume; theoretical work performed by blower and compressor.

AIRPLANE ENGINES

Cooling for. High-Temperature Liquid-Cooling, G. W. Frank. Soc. Automotive Engrs. Jl., vol. 25, no. 4, Oct. 1929, pp. 329–340 and (discussion) 340–343, 25 figs.; see also West. Flying, vol. 6, no. 4, Oct. 1929, p. 56, 1 fig. Requirements of high-temperature cooling liquid; properties of ethylene-glycol; investigation conducted by Materiél Division; dynamometer test of Curtiss V-1570 and D-12 engines; endurance and flight tests of D-12 engine; dynamometer test of high compression-ratio D-12 engine; extremely low fuel consumption; ratio of installed weight to power of liquid-cooled airplane engine considerably reduced by this system.

Design. Effect of Surrounding Temperature on Air-Cooled Engines (Effet de la Température Ambiante sur le Fonctionnement des Moteurs). Bulletin Technique du Bureau Veritas (Paris), vol. 11, no. 9, Sept. 1929, pp. 197–201, 3 figs. Notes on self-ignition and detonation; influence of temperature on performance of engine; experimental results.

Statax. A New Type of Engine for Light Airplanes; Le Statax (Un type nouveau de moteur pour avions legers le statax). Aérophile (Paris), vol. 37, no. 15/16, Aug. 1/15, 1929, pp. 252–253, 1 fig. Description of 7-cylinder 40-hp. air-cooled rotating airplane engine manufactured by Statax Motor A. G.; cylinders are not fixed but turn around fixed axis, being parallel to axis; 40 hp. developed at 1800 r.p.m.; 60- by 110-mm. bore and stroke; 50 kg. weight.

AIRPLANES

Airfoils. Aerodynamic Characteristics of Twenty-Four Airfoils at High Speeds, L. J. Briggs and H. L. Dryden. Nat. Advisory Committee for Aeronautics—Report No. 319, 1929, 32 pp., 45 figs. Aerodynamic characteristics of 24 airfoils are given for speeds of 0.5, 0.65, 0.8, 0.95, and 1.08 times speed of sound as measured in open-jet air stream using models of 1-in. chord; nine members of Standard R.A.F. airfoil used by Army and Navy for propeller design, and five members of Clark Y family differing only in thickness tested; R.A.F. family in which position of maximum ordinate is varied; combined groups; group consisting of three geometrical forms, flat plate, wedge, and segment of right circular cylinder.

Catapults. Accelerations of Transatlantic Mail by Means of Catapult (L'accéleration des courriers transatlantiques par la catapulte). Aéronautique (Paris), no. 124, Sept. 1929, pp. 313–314, 4 figs. Use of catapults on Isle-de-France and Bremen for dispatching mail to shore by airplane is briefly discussed; C.A.M.S. 37 seaplanes and Penhoet catapult employed on Isle-de-France, and Heinkel catapult and Heinkel H.E. 12 seaplane on Bremen.

Propellers. Controllable-Pitch Propeller, T. P. Wright and W. R. Turnbull. Soc. Automotive Engrs. Jl., vol. 25, no. 4, Oct. 1929, pp. 408–415 and (discussion) 415–416, 4 figs.; see also West. Flying, vol. 6, no. 4, Oct. 1929, pp. 57–58. Desirability of controllable-pitch propeller is discussed; added weight will be offset many times by great performance advantages of propeller possessing good efficiency at all conditions of flight and permitting full engine power to be developed when most necessary; few hundred hours' operation should balance added cost of controllable-pitch propellers; problems in design of propellers and construction materials.

Gearing of Aircraft Propellers, T. P. Wright and R. E. Johnson. West. Flying, vol. 6, no. 4, Oct. 1929, p. 58. Advantages and disadvantages of reduction gearing for airplane propellers are discussed; experience shows that net gain does not warrant gearing of engines rated at less than 400 hp. or for airplanes weighing less than 4000 lb.; table shows propeller speed versus limiting propeller diameter on account of limiting tip-speed considerations. Abstract of paper presented before Soc. Automotive Engrs.

The Production of Lift by Propeller Blades, M. M. Munk. Aviation, vol. 27, no. 16, Oct. 19, 1929 (Aeronautical Eng. Supp.), pp. 816–819, 5 figs. Errors in conclusion reached in National Advisory Committee for Aeronautics—Technical Report no. 175, are further discussed; lift created by propeller-blade element and lift created by same element when portion of ordinary airfoil differ considerably from each other; results of wind-tunnel experiments undertaken to support this conclusion are given; different systems are not even likely to confine their effects to lifts only.

Theory of Airplane-Propeller Vibrations (Zur Theorie der Luftschraubenschwingungen), F. Liebers. Zeit. fuer Technische Physik (Leipzig), vol. 10, no. 9, 1929, pp. 361–369, 5 figs. Mathematical analysis for calculation of torsion and bending frequencies in propellers on basis of Rayleigh's variation principle.

Variable-Pitch Propellers, F. W. Caldwell. West. Flying, vol. 6, no. 4, Oct. 1929, p. 59. Forces required to operate control adjustments of variable-pitch propellers are discussed; principal obstacle in way of satisfactory adjustable-pitch propeller. Abstract of paper presented before Soc. Automotive Engrs.

Sheet-Metal Stamping. Sheet Metal Pressing for Airplanes, R. Hudson. Sheet Metal Worker, vol. 20, no. 16, Aug. 9, 1929, pp. 503–504 and 510, 4 figs. Methods employed in sheet-metal department of Boeing Airplane Co., Seattle, for manufacture of airplanes; in manufacture of ailerons and empennages for airplanes, 700-ton press is used to produce corrugated and stream-lined surfaces.

Rocket. Fritz Von Opel Flies 1¼ Mi. in Rocket Plane. Aviation, vol. 27, no. 15, Oct. 12, 1929, p. 769, 1 fig. Brief description of Sander Rak-1 airplane and its first flight propelled by rockets; machine was designed by F. von Opel and F. Sanders.

The Opel Rocket Plane. Aviation, vol. 27, no. 19, Nov. 9, 1929, p. 931, 1 fig. Description of flight of rocket plane developed by F. von Opel and equipment employed; machine used was simple glider, with single cantilever wing of wood construction; fuselage also of wood, with space in rear for box containing rockets; 16 rockets in rows of four fitted into abbreviated fuselage directly behind cockpit; detonation controlled by mechanism placed near left hand of pilot; third trial from point of view of experiment was entirely successful.

Seaplanes. See SEAPLANES.

Wings. The Effect of the Wings of Single Engine Airplanes on Propulsive Efficiency as Shown by Full Scale Wind Tunnel Tests, F. E. Weick and D. H. Wood. Nat. Advisory Committee for Aeronautics—Tech. Notes No. 322, Oct. 1929, 22 pp., 26 figs. In investigation to determine effect of wings on propulsive efficiency open-cockpit single-engine fuselage was tested with and without biplane wings, and closed-cabin fuselage with varying amounts of cowling tested with and without monoplane wings; standard metal propeller and Whirlwind engine used; wings cause reduction of from 1 to 3 per cent in propulsive efficiency; about same for monoplane as for biplane wings.

Wing Construction Development, H. P. Folland. Aircraft Eng. (Lond.), vol. 1, no. 2, Apr. 1929, pp. 48–50, 13 figs. Description of Gloster method of building steel thick high-lift wing sections having high loading per square foot and requiring maximum resistance to deflection and vibration; work carried on by Gloster Air-

craft Co. to develop suitable steel spars for thick wings with regard to strength-weight ratio, rigidity to resist deflection and vibration, cheap construction, ease of assembly, ease of replacement of any part under service conditions, and torsional rigidity.

Wings—A Coordinated System of Basic Design, R. H. Upson. West. Flying, vol. 6, no. 4, Oct. 1929, pp. 59, 140 and 142. Practical coordination of existing data as foundation for judgment in wing design and research; best taper, structurally and aerodynamically makes root chord about five times tip chord; elliptical plan forms possess no great advantages; internally braced wings of ideal proportions; cantilever wing with structural skin can be made surprisingly thin; low-wing monoplane tends to generate induced interference. Abstract of paper presented before Soc. Automotive Engineers.

AIRPORTS

Rating. The Selection of Airports and Their Rating, E. Jones. Airports, vol. 3, no. 4, Oct. 1929, pp. 19–20. Unavailability of airport sites meeting present ideal as to area should not be necessarily permitted to discourage acquirement and improvement of airports of lesser size; improvements must tend toward approval of areas now failing to meet present high ratings; advantages of airport location will not depend entirely upon long-distance passenger-mail-goods conveyance; private owners are greatest purchasers of aircrafts.

AIRSHIPS

Design. The External Forces on an Airship Structure With Special Reference to the Requirements of Rigid Airship Design, H. R. Cox. Roy. Aeronautical Soc.—Jl. (Lond.), vol. 33, no. 225, Sept. 1929, pp. 725–811, 41 figs. System of external forces on airships; factors of safety; estimation of static loading; component for unpitched and pitched flight with no yaw; component for circling flight at O deg. pitch; ship at mast; initial acceleration; deceleration; rapid elevator and rudder movement; varying winds while ship is moored; head resistance; speed when circling; forces due to aerodynamic pressures; coefficients for pressure at point of spheroid; airship shapes.

Metal Construction. Building the Structure of British Rigid Airship R.-101, P. W. Peel. Can. Machy. (Toronto), vol. 40, no. 20, Oct. 3, 1929, pp. 42–47, 5 figs. Details of various constructional members of metal framework in airship R.-101; new processes introduced; degree of accuracy attained never before attempted in airship construction; high shear stresses in web; materials and their treatment; solid drawn steel tubes; die castings; steel stampings; zinc-cadmium solder; bracing cables; difficulties in hardening of stainless steels; drawing of section; of duralumin section; protection against corrosion.

Parseval-Naatz. The Parseval-Naatz Airship 28. Aircraft Eng. (Lond.), vol. 1, no. 4, June 1929, p. 120. Description of semi-rigid airship which has 65,000-cu. ft. capacity; keel runs almost entire length of airship inside envelope and in it are housed gasoline and water ballast tanks and bags; length 130 ft. 4 in.; Siemens-Halske 80-hp. engine.

R 101. The Large Airships of Great Britain (Les grands dirigeables britanniques), L. Mercier. Aérophile (Paris), vol. 37, no. 11/12, June 1/15, 1929, pp. 163–166, 5 figs. Brief description of British airship R-100 precedes discussion of design of R-101; form of hull and construction of frame; nature of metals employed; ballonets for gas, netting and valves used; Beardmore Tornado engines; arrangement of engine nacelles; distribution of pressure on envelop of R-101.

ALLOYS

Age Hardening. Age-Hardening. Metallurgist (Supp. to Engineer, Lond.), Sept. 27, 1929, p. 130. Remarks based on lengthy discussion of age hardening at meeting of Gesellschaft fuer Metallkinde at Duesseldorf; question upon which discussion centered was whether phenomena of age hardening could be accounted for by dispersion theory; certain number of German metallurgists held view that phenomena are too complex to be accounted for by so simple an explanation; what may prove important step toward general acceptance of dispersion theory was explanation of way in which so-called anomalies in hardening phenomena could be readily fitted into dispersion theory.

Aluminum. See ALUMINUM ALLOYS.

Bearing Metals. See BEARING METALS.

Copper. See COPPER ALLOYS.

Magnesium. See MAGNESIUM ALLOYS.

Non-Ferrous. See NON-FERROUS METALS AND ALLOYS.

ALUMINUM

Sheet. Some Aspects of the Commercial Manipulation of Aluminum, C. F. Nagel, Jr. Sheet Metal Worker, vol. 20, nos. 19 and 20, Sept. 20, and Oct. 4, 1929, pp. 611–612, 615, and 642–643. Sept. 20: Essentials in which aluminum differs from other metals; controlling factors of processes; heat treating aluminum alloys; properties of duralumin; changes during aging; mechanical properties of certain alloys in various tempers. Oct. 4; Aging methods and mediums; annealing aluminum; differences of crystallization; growth of crystals; time and temperature important; annealing heat-treatable alloys. Paper presented before Am. Inst. Min. and Met. Engrs.

ALUMINUM ALLOYS

Cold Working. Effect of Cold Rolling on Physical Properties of Metals, R. L. Templin. Rolling Mill Jl., vol. 3, no. 9, Sept. 1929, pp. 393–394, 1 fig. Effects of cold working upon physical properties of aluminum are discussed; rate of strain hardening in cold working indicated by tensile stress; changes in yield point and elongation. Abstract of paper presented before Am. Inst. Min. and Met. Engrs.

Heat Conductivity. Thermal Conductivity of Light Alloys for Pistons, C. Grard and J. Villey. Iron Age, vol. 124, no. 16, Oct. 17, 1929, p. 1036, 1 fig. Influence of copper on conductivity of aluminum and magnesium is shown; alloys of particular value for aircraft engines. Abstract of paper presented before Académie des Sciences.

Welding. Gas Welding Aluminum, W. A. Dunlap. Welding Engr., vol. 14, no. 10, Oct. 1929, pp. 38–43, 7 figs. Welding properties of aluminum and its alloys are discussed; fusion welding with oxy-hydrogen or oxyacetylene torch; apparatus required for welding aluminum; preferable to use oxy-hydrogen flame; importance of flux; welding wire; procedure for welding sheets and castings; preparation of edges; preheating; buckling produced by welding; torch manipulation; welding commercially pure aluminum sheet; strength of welds; finishing welding. Paper presented before Gas Products Assn.

ANEMOMETERS.

Hot-Wire. The Measurement of Fluctuations of Air Speed by the Hot-Wire Anemometer, H. L. Dryden and A. M. Kuethe. Nat. Advisory Committee for Aeronautics—Report, no. 320, 1929, 26 pp., 20 figs. Hot-wire anemometer as promising method for measuring fluctuating air velocities found in turbulent air flow; only obstacle is presence of lag due to limited energy input which makes even fairly small wire incapable of following rapid fluctuations with accuracy; theory of lag; experimental arrangement for compensating for lag for frequencies up to 100 or more per second when amplitude of fluctuation is not too great; experimental test of accuracy of compensation. Bibliography.

AUTOMOBILE ENGINES

Anti-Freeze Solutions. R. A. C. Test Glycerine Anti-Freezing Solution. Motor Transport (Lond.), vol. 49, no. 1283, Oct. 14, 1929, p. 459. Brief description of R. A. C. test of anti-freeze solution consisting essentially of glycerine and water; chemical composition of mixture given.

Bearings, Manufacture of. Bohn Interchangeable Bearings Produced on Low Cost Basis, A. F. Denham. Automotive Industries, vol. 61, no. 16, Oct. 19, 1929, pp. 575–577, 3 figs. Discussion of exactness of method used in manufacture of interchangeable type of bearing for automobile-engine crankcase bore and crankshaft; methods employed by Bohn Aluminum and Brass Corp. in producing interchangeable bearings are discussed; considerable saving effected through use of special machine tools designed by company; these units operate with accuracy that maintains extremely close tolerances required.

Combustion Chambers. Combustion-Chamber Design in Theory and Practice, W. A. Whatmough. Soc. Automotive Engrs. Jl., vol. 25, no. 4, Oct. 1929, pp. 375–383, 11 figs. Discussion of paper published in September 1929, issue of magazine; discussers differ with author on many points of theory while acknowledging improvement in performance made by changes of combustion-head design on English engines; causes of rough operation; temperature control the only detonation remedy; importance of cool pocket over piston; turbulence decreases detonation tendency; effect of clearance space offsetting.

Crankshafts, Heat Treatment of. Heat Treatment of Crankshaft Dies and Forgings, C. B. Phillips. Fuels and Furnaces, vol. 7, no. 2, Nov. 1929, pp. 1761–1763, 3 figs. Crankshafts after finish forging and final upset, are heated in continuous automatic, oil-fired normalizing furnace at temperature of 1650 deg. fahr. and then quenched, eliminating all subsequent heating operations; dies are heated in gas-fired furnace to temperature 1500 deg. fahr. quenched and drawn at temperature of 700–1000 deg. fahr. See Engineering Index, 1928, p. 178.

Pistons, Machining. Survey of Machining Practice for Both Slotted and Unslotted Pistons Indicates a Wide Divergence of Methods Among Manufacturers, A. F. Denham. Automotive Industries, vol. 61, no. 15, Oct. 12, 1929, pp. 518–529, and 550, 12 figs. Comparison of machining methods employed by different companies for unslotted and slotted pistons; differences centered in method of located during machining cycle; considerable variation in major operations while actual turning, cutting, and grinding processes differ with type of unit used; practice of La Salle, Oldsmobile Continental, Viking, Reo, Ford, Graham-Paige, Plymouth, Packard, Dodge, De Soto, and Chrysler.

AUTOMOBILE PLANTS

Material Handling. Electric Industrial Trucks Save Time in Materials Handling, C. B. Crockett. Automotive Industries, vol. 61, no. 19, Nov. 9, 1929, pp. 678–680, 5 figs. Survey of materials handling and use of industrial electric trucks in automobile plants; use of power vehicles in 50 per cent of factories to reduce re-loading, hauling, and moving large unit loads in production; nearly 70 per cent of plants have eliminated rehandling in and out of finished stores and moved material from last operation to carrier; 20 per cent of plants have been able to move incoming materials direct to first operation; shipping on skid platform; processes in Marmon, Studebaker, and E. G. Budd plants.

How the Automotive Industry Set the Pace in Mechanical Handling, F. L. Faurote. Matls. Handling and Distribution, vol. 1, nos. 9, 10, 11, and 12, June, July, Aug., and Sept., 1929, pp. 18–21 and 84, 11–14 and 62, 11–14, 27–29, and 81, 36 figs. Detailed discussion of materials-handling methods of Ford Motor Co., methods of handling pig iron and logs; assembling methods.

Material Handling Methods Interwoven With Production Schedules and Accounting. Automotive Industries, vol. 61, no. 15, Oct. 12, 1929, pp. 536–538, 2 figs. Additional details to article published in June 8 issue of magazine are given, which described methods employed by Chrysler Corp. to get small parts to assembly line; new scheme of production and materials-handling control employed by Continental Motors Corp. is outlined; methods of Dodge, Oakland, Studebaker, Ford, Hupmobile, and Timken-Detroit are commented upon.

X-Ray Laboratories. Radiographic Analysis of Metals Suitable for Stressed Parts, W. L. Fink and R. S. Archer. Automotive Industries, vol. 61, no. 16, Oct. 19, 1929, pp. 571–574, 9 figs. Description of X-ray laboratory installed at new foundry of U. S. Aluminum Co. at Fairfield, Conn. field of advantageous use of radiography in metal industry is determined by balancing cost, which is comparatively high, against benefits obtainable through accurate inspection; X-ray apparatus employed was well developed for both diagnostic and deep-therapy medical work; general principles underlying radiography; most of radiographic work has been done on highly stressed parts.

AUTOMOBILE MANUFACTURE

Production Control in. Economic Size of Production Lots May Be Determined by Formulae F. E. Raymond. Automotive Industries, vol. 61, no. 15, Oct. 12, 1929, pp. 541–543, 1 fig. See also Am. Mach. vol. 71, no. 16, Oct. 17, 1929, pp. 669–670. Manufacturing control through economic size of production lots is discussed; application of mathematical analysis to manufacturing control; certain operations now intermittent can be made continuous profitably even though manufacturing equipment for present must remain idle during certain periods; determination of limits of economic range; formulas for economic production quantity. Paper presented before Soc. of Automotive Engrs.

AUTOMOBILES

Brakes. Double-Acting Vacuum-Release Brake (Eine doppeltwirkende Unterdruck-Servobremse). Automobiltechnische Zeit. (Berlin), vol. 32, no. 29, Oct. 20, 1929, pp. 645–646, 1 fig. Details of latest modification of Trachsel servo brake; invented by Swiss engineer; spring tension as well as vacuum are now utilized simultaneously for releasing brake.

Front-Wheel Drive. Front-Axle Movements and Front-End Behavior, W. B. Barnes. Soc. Automotive Engrs. Jl., vol. 25, no. 4, Oct. 1929, pp. 417–420, 4 figs. Description of device de-

veloped to give graphical record of front-axle movements while car is on road; startling facts concerning amplitude and character of axle vibrations in various cars; when striking obstruction or during brake application axle as whole may rotate forward as much as 5 deg., giving negative value to caster angle; instantaneous center of rotation may vary; principles embodied in design of Auburn front-drive car are explained.

Riding Quality. The Relation of Riding-Quality to Angular Car-Acceleration, M. L. Fox. Soc. Automotive Engrs. Jl., vol. 25, no. 4, Oct. 1929, pp. 358-363 and 416 including discussion, 7 figs. Description of gyro-accelerometer for recording angular velocity, angular acceleration, and total angle turned; standard-bump test; results of tests at Iowa City, and at proving grounds of General Motors Corp. and Studebaker Corp.; standard of riding quality to be known as University of Iowa standard Riding Scale; other uses for gyro-accelerometer in connection with automobile design; instrument adapted to furnish total amount of angular velocities or accelerations.

Shock Absorbers. Two-Way Action With One Cylinder in Thompson Shock Absorber. Automotive Industries, vol. 61, no. 16, Oct. 19, 1929, pp. 578, 2 figs. Description of shock absorber designed by Thompson Products, Inc., Cleveland, Ohio, which checks return of chassis springs for normal position in either direction, that is from compression or from rebound; resistance to return motion of chassis springs varies, owing to change of effective length of lever arm through which piston acts on crank; device comprises housing, arm and shaft, crank, piston, valve sets, and rocking cylinder; although only single cylinder is employed, two-way action is obtained.

Steering Gears. Recent Steering Units (Neuzeitliche Lenkradgetriebe). Automobiltechnische Zeit. (Berlin), vol. 32, no. 22, Aug. 10, 1929, pp. 472-473, 5 figs. Description of recent developments of Gemmer Co., Germany; modified form of Globoid worm drive; in case of small cars two tooth worm gear and in case of larger models cam, are used; conical roller bearings absorb both radial and axial stresses; cam decreases friction to remarkable degree and insures easy steering.

AUTOMOTIVE FUELS

Standardization. Standardization of Automotive Fuels (Erwaegungen zu einer Normung von fluessigen Kraftstoffen), W. Schmidt. Automobiltechnische Zeit. (Berlin), vol. 32, no. 26, Sept. 20, 1929, pp. 569-570. Author suggests test method for standardization of oil fuel, according to which fuel would be tested only in engine, using standard experimental engine for this purpose.

B

BEARING METALS

Properties. Bearing Metals With Lead, Antimony and Tin Basis (Ueber Lagermetalle aug Blei-, Antimon- und Zinn-Basis), H. Mueller. Zeit. fuer Metallkunde (Berlin), vol. 21, no. 9, Sept. 1929, pp. 305-309 and (discussion), 309-310, 15 figs. Physical requirements of modern highly stressed bearing metals are discussed, i.e., Brinell hardness tensile strength, dilation, and wear; texture and its interrelation with requirements mentioned; suggestions for further development.

BELTS AND BELTING

Losses. Losses of Belt Drive With Application of Small Pulleys, With Special Regard to Resistance of Bending (Verluste der Riementriebe bei Verwendung kleiner Scheiben, etc.), A. E. Mueller. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens (Berlin), no. 318, 1929, 22 pp., 33 figs. Tests to determine those losses in belt drives, especially bending losses, which influence life of belt; tests were carried out in materials testing laboratory of University of Dresden; subject is exhaustively treated from theoretical, mathematical, and practical point of view; test results, curves, and tables.

Testing. Modern Belt Testing (Neuzeitliche Riemenpruefung), F. Pelckmann. V.D.I. Zeit. (Berlin), vol. 73, no. 40, Oct. 5, 1929, pp. 1425-1427, 6 figs. Modern testing equipment; explanation of engineering terminology; friction coefficient independent of load; test results and their utilization; testing standards.

BOILERS

Control. Incorrect Type of Steam Regulator as Cause of Water Priming (Ein unzweckmaessiger Dampfregler als Ursache fuer Wassermitreissen), K. Schiebl. Waerme (Berlin), vol. 52, no. 37, Sept. 14, 1929, pp. 720-722, 6 figs. Cause for periodic priming in vertical-tube boilers is described to by-pass regulator between high and low-pressure system with too large a valve and with only one pressure stroke; steam conditions are followed with aid of diagrams.

Corrosion. Heat Conductivity of Boiler Scale (Die Waermeleitfaehigkeit von Kesselstein), A. C. Eberle. Archiv fuer Waermewirtschaft (Berlin), vol. 10, no. 10, Oct. 1929, pp. 334-336, 7 figs. Results of research carried out in past few years show that heat-conductivity coefficient of boiler scale depends to great extent on its porosity, and this is influenced to marked degree by composition of scale; porosity of samples studied fluctuated between 6 and 80 per cent and conductivity coefficient varied accordingly between 0.1 and 2.

Failures. Cracking of Boiler Plates, A Pomp and P. Bardenheuer. Metallurgist (Supp. to Engineer, Lond.), Sept. 27, 1929, pp. 131-132, 1 fig. Extensive application is made of Fry's reagent to reveal areas in which local plastic straining of steel has occurred, and which therefore has reduced ductility and increased solubility in corrosive media; three cases of cracking of boiler plates in service are discussed. Review of paper, previously indexed from Mitteilungen aus dem Kaiser-Wilhelm Institut fuer Einsenforschung zu Duesseldorf, No. 128, 1929.

High-Pressure. Industrial Applications of Loeffler High-Pressure Boiler (Les applications industrielles de la chaudière Loeffler à haute pression). Génie Civil (Paris), vol. 95, no. 15, Oct. 12, 1929, pp. 355-359, 9 figs. Principle of system is outlined; details of locomotive fired with Loeffler boiler; pulverized-fuel firing of Loeffler boiler; immediate reheating of steam.

Marine, Design of. Type of Marine Boiler with High Steaming Capacity (Note sur un type de chaudière marine à haute vaporisation), E. Rauber. Bul. Technique du Bureau Veritas (Paris), vol. 11, no. 8, Aug. 1929, pp. 170-172, 2 figs. Details of design which was developed with purpose of increasing steaming capacity of tubes with too low output; results of tests on industrial and marine boilers.

Operation—Load Curves. How to Prepare a Schedule for Economic Boiler Loadings, H. B. Reynolds. Power, vol. 70, nos. 15 and 16, Oct. 8 and 15, 1929, pp. 553-557 and 593-594, 14 figs. Oct. 8: Discussion of importance of correct boiler scheduling; preparation of curves and tables from which boiler-room operator can determine number of fired and active boilers for greatest dollar economy; table giving cost data; boiler-operation curves. Oct. 15: Plant with maximum load of 100,000 kw. may incur losses of $296 to $1039 per day by unscientific loading; several load curves are given.

Wood-Waste and Pulverized-Coal-Fired. 300 Per Cent Rating Obtained With Wood Refuse and Powdered Coal in the Same Furnace, H. R. Lambright. Ry. Elec. Engr., vol. 20, no. 10, Oct. 1929, pp. 550-552, 3 figs. Boiler settings of hollow air-cooled construction and water-cooled side walls designed to burn both wood refuse and powdered coal; handling of wood refuse; automatic control of feed; method of introducing air for combustion and use of water walls in furnace of unusual height are features of interest in this plant; section through boiler, showing furnace design and fuel-handling equipment.

BORING MILLS

Large. A Gigantic Boring and Turning Mill. Engineer (Lond.), vol. 148, no. 3850, Oct. 25, 1929, p. 449, 1 fig. Mill of extraordinary large dimensions recently underwent successful tests in works of its designers and builders, Scheiss Defries A.G. of Duesseldorf; principal dimensions and weights of mill, together with limiting dimensions and weights of work it will take, are given.

C

CARBON DIOXIDE

Properties. The Thermal Properties of Carbon Dioxide in the Gaseous, Liquid, and Solid States, R. Plank and E. J. Kuprianoff. Information on Refrigeration—Bul. (Paris), no. 11, Mar. and Apr. 1929, pp. 3p-15p, 3 figs. partly on supp. plates. Discussion of such factors as: specific volume, equilibrium, latent heats, enthalpies, entropy; tables and charts for carbon-dioxide in solid, liquid, and vapor states.

CARBON DIOXIDE COMPRESSORS

Design. Design Problems of a Carbon-Dioxide Refrigeration Machine, T. Mitchell. Power, vol. 70, no. 15, Oct. 8, 1929, pp. 566-567, 1 fig. Solution of various problems may be grouped under two headings: design of pistons and arrangement of parts centering about shaft; illustration of inclosed vertical-dioxide compressor.

CARS

Refrigerator. A Resume of the Mobile Refrigerator, L. K. Wright. Ice and Refrigeration, vol. 77, no. 4, Oct. 1929, pp. 204-206. Insulation thickness of cars; shipment of produce; circulation of air in cars; artificial refrigeration of cars; refrigerated barges; refrigerated milk cars and ice-cream trucks; overhead bunkers in freight cars; ice consumption of overhead bunker cars.

CASTINGS

Strength. Strength of Metal Castings and Relation of Iron to Method of Casting (Die Festigkeitseigenschaften von Metallguss einschliessl. Eisen in Abhaengigkeit von der Giessweise), G. Schreiber and H. Menking. Zeit. fuer Metallkunde (Berlin), vol. 21, no. 9, Sept. 1929, pp. 297-302 and (discussion), p. 302, 22 figs. Cause of fluctuations in strength values of all cast metals is investigated; various physical influences are explained with aid of testing model.

COAL

Low Temperature Carbonisation. Low-Temperature Carbonisation. Engineer (Lond.), vol. 148, no. 3847, Oct. 4, 1929, pp. 350-352. Discussion at meeting held by Institute of Fuels following inspection by members of number of low-temperature carbonization plants which are being tried out on large scale at gas works in and around London; Richmond and Greenwich plants, K. S. G. plant at Greenwich, and Salermo plant at Fulham were discussed.

Pulverized. See PULVERIZED COAL.

COAL HANDLING

Docks. Unloading a Car of Coal a Minute, E. L. Whitney. Matls. Handling and Distribution, vol. 1, no. 12, Sept. 1929, pp. 10-21, 2 figs. Coal-handling equipment of New York Central Railroad Co., Toledo, Ohio, is described; motor equipment aggregates 600 hp. and will permit dumping of car of coal in one minute; machine will handle cars 64 ft. in length and gross weight of 165 tons.

CONVEYORS

Gravity Spiral. Save Elevator Time With Chutes, H. C. Chubbuck. Matls. Handling and Distribution, vol. 1, no. 12, Sept. 1929, pp. 34 and 56, 1 fig. Special chute installations in Camden warehouse of Baltimore and Ohio Railroad is described.

Pneumatic. Pneumatic Conveying, J. D. Lloyd. Materials Handling and Distribution, vol. 3, no. 1, Oct. 1929, pp. 30-31, 6 figs. Suction system and pressure system are two main types described; data of installations are given.

COPPER ALLOYS

Melting. Development of New Deoxidation and Melting Process for Metals, Especially Copper Alloys (Die Entwicklung eines neuen Desoxydations und Schmelzverfahrens fuer Metalle insbesondere fuer Kupferlegierungen), W. Reitmeister. Giesserei (Duesseldorf, vol. 16, no. 41, Oct. 11, 1929, pp. 945-952 and (discussion) 952-953, 4 figs. Relations between copper and iron alloys are set forth; casting difficulties with bronze; relation between tendency to segregation in raw and cast material; deoxidation of molten bronze with carbon; influence of deoxidation on one segregation, and other causes for zone segregation; new deoxidation process is described.

CRANES

Cable. Cable Cranes (Kabelkranar), H. Larsson. Teknisk Tidskrift (Stockholm), vol. 59, no. 25, June 22, 1929, pp. 345-348, 13 figs. Description of different cable cranes with spans up to 400 m. and 12 tons lift, giving construction and operation costs.

CUPOLAS

Design. Cupolas and Their Main Dimensions (Der Kupolofen und seine Hauptabmessungen), L. Schmid. Giesserei-Zeitung (Berlin), vol. 26, no. 20, Oct. 15, 1929, pp. 567-577, 4 figs. Notes on melting and combustion processes; diameter cupola shaft; cross-section of shaft; cupola nozzles; dimensions of blower.

The Ordinary Cupola and Poumay Cupola, Poumay, Jr. Fonderie Moderne (Paris), vol. 23, July 10, 1929, pp. 283-291. Proof is offered that ordinary cupola is not well understood, and that many of its established theories are in reality hypothetical; coke combustion is explained; opinions of many authors expressed in magazine articles are quoted; obtaining certain ratio of

combustion in cupola; dimensions necessary in cupola; details of Poumay cupola with which very hot and pure cast iron can be obtained with small percentage of charge coke.

CUTTING TOOLS

Lathe, Cutting Speeds of. Turning With Shallow Cuts at High Speeds, H. J. French and T. G. Digges. Am. Soc. Mech. Engrs.—Advance Paper, no. 17, for mtg. Dec. 2 to 6, 1929, 31 pp., 42 figs. Method for testing lathe tools under shallow cuts and fine feeds; relations between cutting speed, feed, depth of cut, and tool life for carbon and high-speed tool steels; different forms and tool life when cutting dry and with water or lard oil; heat treatment and chemical composition of tools; effects of cobalt, nickel, molybdenum, arsenic, antimony, phosphorus, sulphur, copper, tin, aluminum, titanium, and tantalum; results compared with those obtained under heavy duty.

D

DIES

Forging, Manufacture of. Forging Dies Made by Improved Methods, C. B. Phillips. Iron Trade Rev., vol. 85, no. 15, Oct. 10, 1929, pp. 901–903, 5 figs. Practice employed in die-making division of Studebaker Corp., South Bend, Ind., is described; die blocks are bought annealed, impressions cut, and block heat treated and finished; careful heat treating methods described; daily inspection of dies in use; two distinct methods used in forging crankshaft with these dies outlined; new block steel employed for crankshaft and all heat-treating operations eliminated except normalizing.

DIESEL-ELECTRIC POWER PLANTS

Costs. Diesel Engine Power Costs, E. J. Kates. Power Plant Eng., vol. 33, no. 20, Oct. 15, 1929, pp. 1114–1115, 1 fig. Operating costs of well designed and modernly equipped Diesel plant of Vulcan Rail and Construction Co.; chart showing relationships between output, efficiency, load factor, and operating cost.

Diesel Engine Power Costs for 1927–1928, F. Edler. Power Plant Eng., vol. 33, no. 21, Nov. 1, 1929, pp. 1168–1170. Analysis of Diesel power costs indicate trend toward further plant refinement and need of standardization of cost methods; summary of Diesel-engine data; summary of Diesel-plant operating costs.

DIESEL ENGINES

Supercharging. Compounding and Supercharging of Diesel Engines (La question du compoundage et de la suralimentation du moteur Diesel), Gautier. Bul. Technique du Bureau Véritas (Paris), vol. 11, nos. 7 and 8, July and Aug. 1929, pp. 155–159 and 177–180, 18 figs. Engines of 4-stroke cycle only are dealt with; notes on recovery of energy lost in exhaust gas; supercharging and means of effecting it; supercharging with exhaust-gas turbo-compressor; comparison of three types of engines; standard 4-stroke supercharged 4-stroke and standard 2-stroke engines; results of tests; conclusions.

New System of Supercharging Werkspoor Engines (Nouveau Systeme de Suralimentation des Moteurs Werkspoor), Abbat. Bul. Technique du Bureau Véritas (Paris), vol. 11, no. 7, July 1929, pp. 138–139, 1 fig. Details of Van Essen supercharging system employed in Werkspoor engines installed in oil tanker, Megara; instead of supplying necessary air from a rotary blower, underside of main working pistons is utilized; box casting around cylinder forms receiver from which air is supplied to inlet valve at alternate strokes of piston; results of running tests.

DIPHENYL

Properties. Diphenyl. Indus. Power, Nov. 1929, pp. 41–42, 146 and 148, 2 figs. New substitute for water in heat engineering; yellowish crystalline substance at temperatures below its boiling point, and smelling much like moth balls; threatens to displace water wherever more rapid heat transferring is necessary; has no corrosive action on any material; it will burn at high temperatures, presumably around 1800 deg. fahr.; not to be confused with diphenyl oxide, which is not so stable, and has not proved satisfactory because of tendency to carbonize in tubes; preliminary table of values for diphenyl.

DOVETAILING MACHINES

New Type. A New Dovetailing Machine. Eng. Progress (Berlin), vol. 10, no. 10, Oct. 1929, p. 266, 1 fig. Description of small tool built by Wilhelm Grupp Werkzeugund Maschinenfabrik under name of "Wigo" dovetailer; in this machine, cutter head is movable longitudinally and transversely on roller running upon heavy cylindrical ways, while ballbearing construction permits entire carriage to be easily moved by hand to right and left as desired; carriage guiding arrangement is patented.

E

ELECTRIC FURNACES

Heat-Treating. Electric Furnaces for the Heat Treatment of Steel, C. H. S. Tupholme. Iron and Steel Industry (Lond.), vol. 3, no. 1, Oct. 1929, pp. 11–13, 4 figs. Description of series of electric reheating furnaces designed by Brown Boveri and Co.; framework of reheating furnaces with vertical muffle; special charging device designed for large furnaces treating sheet metal, billets, rods, and tubes; methods of regulation; pyrometer equipment; reheating for rolling and wire drawing.

ELEVATORS

Electric, Safety Devices for. Safety Devices for Elevators (Ueber Sicherheitsvorrichtungen an Aufzuegen) Waerme (Berlin), vol. 52, no. 42, Oct. 19, 1929, pp. 794–795, 1 fig. Description of modern safety methods and equipment including shaft-door closing, counterweights, etc.

EVAPORATION

Heat Transmission and. Evaporation and Heat Transmission (Verdunstung und Waermeuebergang), E. Schmidt. Gesundheits-Ingenieur (Munich), vol. 52, no. 29, July 20, 1929, pp. 525–529, 1 fig. Derivation of differential equations; application of these equations to study of condensation on cold surfaces.

F

FLOW OF FLUIDS

Research. Investigations Into the Flow of Fluids (Ergebnisse aus dem Stroemungsinstitut der Technischen Hochschule Danzig), G. Fluegel. Werft-Reederei-Hafen (Berlin), vol. 10, no. 16, Aug. 22, 1929, pp. 335–337, 5 figs.; see translated abstract in Mar. Engr. and Motorship Bldr., Oct., pp. 426–427. Description of equipment of Institute for Hydrodynamics and Aerodynamics of Danzig Technical University, including wind tunnel, circulating water tank for testing floating models, and hydraulic laboratory for stream-flow research on small models; ease with which otherwise complicated flow phenomena, such as through turbines and scavenge process in Diesel engines, can be investigated, is emphasized.

FLOW OF GASES

Measurement of. Simplified Formula for Calculating Velocity of Escaping Gases (Forenklad utstromningsformel), B. A. Afzelius. Teknisk Tidskrift (Stockholm), vol. 59, no. 24, June 15, 1929 (Mekanik), pp. 82–83, 2 figs. Three formulas are evolved by which velocity of escaping gases of all pressures beyond critical may be determined with accuracy of less than 1 per cent.

FLOW OF STEAM

Pipes. Simplification of Calculation With Trottle Flange Measurement (Forenkling av raknearbetet vid strypflans-matningar), C. E. Nilson. Teknisk Tidskrift (Stockholm), vol. 59, no. 29, July 20, 1929 (Mekanik), pp. 85–96, 7 figs. Adquist and Haerlin's Formulas for measuring steam flow in pipes are given and from these are developed formulas that are accurate, but much simpler.

FORGING

Time Elements in. Study of Time in Forging Operations (Étude des temps de forgeage), L. Faure. Arts et Metiérs (Paris), vol. 82, no. 106, July 1929, pp. 241–248, 14 figs. Elements entering into time in forging are discussed covering preparation of work, tools, and fire, time for reheating, time for rough forging, and finishing to exact form and trimming, time for inspection, time for displacement, and lost time.

FUELS

[See COAL; PULVERIZED COAL.]

FURNACES, ANNEALING

Charging. Tube-Annealing Furnaces With Mechanical Charging (Rohrgluehofen mit mechanischer Beschickung), H. Fey. Stahl und Eisen (Duesseldorf), vol. 49, no. 44, Oct. 31, 1929, pp. 1589–1590, 2 figs. Details of new double tube-annealing furnace with mechanical charging equipment, made by Ofenbau Gesellschaft, Duesseldorf; equipment consists of moving truck with two movable cars; when annealing of tubes is completed, first car is loaded with new tubes, second one rolls into furnace and carries complete charge out; then whole unit moves to side, so that furnace can be recharged by first car.

Rotary. Multiple-Hearth Rotary Furnace. Iron Age, vol. 124, no. 14, Oct. 3, 1929, p. 908, 1 fig. Description of rotating furnace for bluing, drawing, annealing, and heating at temperatures from 700 to 1650 deg. fahr., which is produced by Strong, Carlisle & Hammond Co.; central heating chamber is surrounded by 10 compartments for holding work.

G

GAS ENGINES

Testing. Complete Thermodynamic and Experimental Study of a Gas Engine (Etude thermodynamique et expérimentale complète d'un moteur à gaz), A. Duchèsne. Revue Universelle des Mines (Liége), vol. 72, no. 4, Aug. 15, 1929, pp. 97–107, 32 figs. Study of test of May 10, 1927; tabular data and detailed discussion of results; comparison of two tests; correction of errata in issues of Jan. 1, Feb. 1, and 15, Apr. 1, and May 1, 1929.

GAS PRODUCERS

Design. Depth of Fuel Bed, Load, and Steam Addition in Gas-Producer Practice (Brennstoffschutthoehe, Belastung und Dampfzusatz im Gaserzeugerbetriebe), Gwosdz. Brennstoff und Warmewirtschaft (Halle), vol. 11, nos. 13 and 14, July 1929, pp. 229–232 and 251–254. Study of influence of fuel-bed depth on gas producers which may have favorable bearing on process of gasification with pure oxygen mixed with steam, a process which is now in development.

GAS TURBINES

New Types. New Recommendations for Solution of Gas-Turbine Problem (Neue Vorschlaege zur Loesung des Gasturbinenproblems), K. Baetz. Waerme (Berlin), vol. 52, no. 41, Oct. 12, 1929, pp. 781–786, 13 figs. Turbines with circulating combustion chamber are discussed, and advantages set forth; special types are developed as aircraft and steam-gas, or steam-oil turbines; latter can be employed for high output as stationary machine.

GASES

Ignition Temperatures of. Ignition Temperatures of Mixtures of Carbon Monoxide With Air (Sur les témpératures d'inflammation des melanges of oxyde de carbone et d'air), M. Prettre and P. Lafitte. Académie des Sciences—Comptes Rendus (Paris), vol. 188, no. 22, May 27, 1929, pp. 1403–1410. Ignition temperatures were found to be fairly constant and to have value of 655 deg. cent. for mixtures containing between 10 and 40 per cent carbon monoxide; for greater proportions of carbon monoxide, ignition temperature increased with percentage of carbon monoxide until value of 727 deg. was obtained for mixture containing 72.9 per cent carbon monoxide.

GEAR-CUTTING MACHINES

Bevel-Gear Rougher. Full-Automatic Bevel Gear Rougher. Iron Age, vol. 124, no. 16, Oct. 17, 1929, p. 1043, 2 figs. Description of four-spindle gear rougher manufactured by Gleason Works, for large quantity rough cutting of straight bevel gears of sizes ordinarily used in differentials of automobiles; hydraulic operation; machine is entirely automatic, only duty of operator being to keep four magazines supplied with bevel gear blanks; capacity up to three diametral pitch; maximum and minimum feed movement of workslide, 1 in. and 3/8 in., respectively.

H

HARDNESS TESTING

Methods. "Cloudburst" Hardness Testing. Iron and Steel Industry (Lond.), vol. 3, no. 1, Oct. 1929, p. 28, 2 figs. Latest improvements and modifications adopted in applying Cloudburst method for hardness testing are given; test is applied to whole surface of many articles simul-

taneously; hardening is effected by same machines and is continuation of same process as that used in hardness testing.

Modern Method for Testing of Materials in the Workshop (Ein Neuzeitiges Verfahren zur Werkstattmaessigen Pruefung von Werkstoffen), C. Sonanini. Werkstattstechnik (Berlin), vol. 23, no. 16, Aug. 15, 1929, pp. 495–496, 5 figs. Usual methods of hardness testing and their advantages and disadvantages; hardness coefficient and its relation to breakdown strength; description of new hardness tester.

HEAT-INSULATING MATERIALS

Thermal Conductivity. Determining the Thermal Conductivity of Heat Insulating Materials, H. Stiles. Chem. and Met. Eng., vol. 36, no. 10, Oct. 1929, pp. 625–626, 2 figs. Description of apparatus for determining heat transfer which has advantage that plant operators can be trained to use method quite satisfactorily; apparatus was designed by writer primarily for purpose of testing heat-insulating properties of wallboard and certain other products made from cornstalks in chemical engineering laboratories of Iowa State College.

HOISTS

Ore. Hecla's New 2100-Hp. Hoist Will Handle 2000 Tons of Ore in Nine Hours. Eng. and Min. Jl., vol. 128, no. 17, Oct. 26, 1929, pp. 674–675, 2 figs. Notes on installation at Burke, Idaho, to go into operation on Nov. 15, hoisting material from Star and Hecla Mines; can work to maximum depth of 5000 ft. at speed of 2400 ft. per min.

HYDRAULIC TURBINES

Design. Lines of Development and Trends in Present-Day Design of Hydraulic Turbines (Linee di Sviluppo ed Orientamenti costruttivi attuali per le turbine idrauliche), M. Medici. Elettrotecnica (Milan), vol. 16, nos. 19 and 20, July 5 and 15, 1929, pp. 438–448 and 461–468, 52 figs. Review of recent progress in design and construction of reaction turbines, diffusers, rotors, draft tubes, etc. with special reference to Kaplan turbines and Pelton wheels; notes on German, Swiss, and American practice.

Testing. Measurements of Water Volume in Testing Turbines in the Hammarfors Power Station (Vattenmangdsmatningen vid provningen av turbinerna i Hammarforsens kraftverk), B. Norsell. Teknisk Tidskrift (Stockholm), vol. 59, no. 42, Oct. 19, 1929 (Mekanik), pp. 131–132, 4 figs. Account of how two turbines were tested; turbines together draw 100 cu. m. water per sec. with head of 19.7 m. and efficiency of 93 per cent was reached.

Thermometric Method of Measuring of Efficiency Coefficient of Hydraulic Turbines (Méthode thermométrique de mésure du rendement des turbines hydrauliques), L. Barbillion. Revue Générale de Electricité (Paris), vol. 26, no. 13, Sept. 28, 1929, pp. 487–497, 11 figs. Method is based on measurement of temperature differences; details of method and equipment required and measures to be taken in order to obtain satisfactory results.

HYDROELECTRIC POWER PLANTS

Conowingo, Md. The Conowingo Hydro-Electric Development. Engineering (Lond.), vol. 128, nos. 3328 and 3329, Oct. 25 and Nov. 1, 1929, pp. 515–518 and 551–554, 54 figs. partly on supp plates and p. 560. Oct. 25: Plant as at present developed can produce, with all units working, 378,000 hp.; eventual output will be 594,000 hp.; development consists of dam and power house incorporated in dam structure. Nov. 1: Details of installation of larger gates used for normal spillway section; power plant and equipment, which at present consists of 7 units, with 2 station generators.

Operation. Simple Basis for Securing Efficient Hydro Operation, F. Nagler. Elec. World, vol. 94, no. 18, Nov. 2, 1929, pp. 875–878, 4 figs. Determination of characteristics of unit performance is necessary in order to make fullest use of available water; calculation of operating curve does not require complete test of unit, but may be based on index of one factor; operating curves developed from velocity gage index; from current-meter index, and from impact-gage index.

Power Calculation. Graphic Representation of Energy to Be Derived From a Proposed Hydroelectric Installation (Représentation graphique facilitant la recherche d'aménagements hydro-électriques rationnels), R. Blom. Houille Blanche (Lyon), vol. 28, no. 147–148, Mar.-Apr. 1929, pp. 36–38, 2 figs. Description and illustration of systems of graphs to show amount of water available from river basin and to estimate distribution of water in river for power development between two heads in order to determine best sections to be utilized for plurality of stations.

Remote Control. Automatic Remote Control of Hydraulic Machinery of the Achensee Power Plant in Tyrol (Die automatische Fernregulierung der Wasserkraftmaschinen im Achensee-Kraftwerk der Tiroler Wasserkraftwerke A.-G.), H. Latzko and O. Plechl. Elektrotechnik u. Maschinenbau (Vienna), vol. 47, no. 36, Sept. 8, 1929, pp. 791–798, 8 figs. Layout of network and formulation of problem; remote-control equipment supplied by Hartmann and Braun; wiring diagrams; operating experience and diagrams; comparison of results obtained with manual regulation.

I

INDUSTRIAL MANAGEMENT

Plant Engineering Organization. A Practical-Ideal Organization for Plant Engineering, L. C. Morrow. Indus. Eng., vol. 87, no. 10, Oct. 1929, pp. 504–508, 3 figs. Composite chart of plant engineering function, and personnel of plant engineering department; organization charts of 15 plants; table giving place of plant engineering function in 15 plants; table of equipment for which plant engineering organization is factor in selection; kinds of work included as part of plant engineering function.

Production Control. See AUTOMOBILE PLANTS; STEEL FOUNDRIES.

Production Costs. Controlling Production Costs in the Small Shops, E. A. Terrell. Am. Mach., vol. 71, no. 16, Oct. 17, 1929, pp. 649–653, 11 figs. Description of forms and practices used successfully by one company for keeping posters on cost of production; purchasing orders, work orders, and stock copies are shown. (To be continued.)

Time Study. Determination of Maximum Efficiency in Continuous Production (Bestimmung der hoechstmoeglichen Leistung bei der Fliessfertigung), K. Rummel. Archiv. fuer das Eisenhuettenwesen (Duesseldorf), vol. 3, no. 4, Oct. 1929, pp. 319–324, 10 figs. Method is described, for application in difficult cases, according to which production diagram is plotted and utilized as control chart and load chart; examples are given of applications in rolling mill; influences effecting time required for working sequences and herewith maximum obtainable efficiency.

INTERNAL-COMBUSTION ENGINES

Crankshafts. The Design of Dynamically Balanced Crankshafts for Two-Stroke-Cycle Engines, P. Cormac. Engineering (Lond.), vol. 128, no. 3326, Oct. 11, 1929, pp. 458–461, 1 fig.; see also letter to editor, by C. R. King, in no. 3327, Oct. 18, p. 507. In general, with two-stroke engines, best balance is obtained only when definite firing order is combined with special spacing of cylinders; where, as with engines of less than five cylinders in line, it is not possible to obtain complete primary balance, out-of-balance effects should be minimized by using suitable counter-balance masses on crankshaft; cases are taken up of 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, and 16 cylinders.

Scavenging. Scavenging and Supercharging of Two-Cycle Engines (Spuelung und Aufladung bei Zweitaktmotoren), E. Stier. V.D.I. Zeit. (Berlin), vol. 73, no. 39, Sept. 28, 1929, pp. 1389–1391, 10 figs. Test results show how through interconnection of scavenging air, line of suitable proportions between cylinder and receiver, constant-pressure scavenging can be replaced by scavenging method with increased pressure and energy of scavenging air can be utilized for subsequent supercharging purposes.

Specific Power of. Problem of Specific Power of Liquid-Fuel Engines (La question de la puissance specifique des moteurs à combustible liquide), A. Coppens. Union des Ingénieurs sortis des Ecoles Spéciales de Louvain (Brussels), vol. 56, no. 3, Aug. 15, 1929, pp. 3–52, 18 figs. Capacity of engine per unit of weight or inversely; horsepower per kg. engine weight is dependent on inherent characteristics of engine and its calculation; curves, tables, and design data for various types of engines in different fields of application.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES.]

L

LATHES

Multiple - Tool. Multiple Machine - Tool Operation and Multiple-Machine Piece Rates (Mehrbankbedienung und Mehrbankakkord), E. Hermann. Werkstattstechnik (Berlin), no. 18, Sept. 15, 1929, pp. 532–535, 3 figs. Conditions under which multiple-tool operation is efficient; output possibilities with relation to working times; dead time; time in-put, costs, contract wages, limits of efficiency; wage-payment plans.

LIGHTING

Industrial Intensities for Use in. Profitable Foot-Candles, M. Luckiesh. Elec. World, vol. 94, no. 15, Oct. 12, 1929, pp. 743–744. In case of lighting, with its many psycho-physiological factors, maximum level of illumination fixed by law of diminishing returns is not so readily determined; it has become necessary not only to supply data on science of seeing, but also to insure its correct interpretation; table of results from test on effect of lighting is given; conclusion from data is that, where critical vision is required, 100 foot-candle represents economic level of illumination.

LOCOMOTIVES

Design. Theory of Locomotive Performance in Its Development (Die Leistungstheorie der Lokomotive in ihrer Entwicklung), H. Nordman. V.D.I. Zeit. (Berlin), vol. 73, no. 40, Oct. 5, 1929, pp. 1413–1416. Theory of initial train resistance; power characteristics of locomotives originally neither properly represented nor interpreted; better understanding of these principles at present but still presupposes unchangeability of output of full load of boiler; cognizance of dependance of minimum output on speed.

Diesel vs. Steam. Economic Comparison of the Steam Locomotive With Different Types of Diesel Locomotives. Locomotive (Lond.), vol. 35, no. 446, Oct. 15, 1929, pp. 384–385. Economic value of steam locomotive as compared with different types of Diesel; description of test run together with test results; conclusion is drawn that Diesel locomotive is economical, although it is only in early stages of development.

4-8-4. Ten 4-8-4 Type Locomotives for the D. and R. G. W. Ry. Mech. Engr., vol. 103, no. 10, Oct. 1929, pp. 621–623, 3 figs. Design to traverse 21 deg. curves and negotiate 3.3 per cent grades; cylinders 27 by 30 in.; driving wheels 70 in.; steam pressure 240 lb.; rated tractive force 63,700 lb.; total engine weight in working order 418,150 lb.; total engine wheelbase 44 ft. 5 in.; general description of test drivers.

High-Pressure. High Pressure Locomotive Developments, A. F. Steubing. Am. Soc. Mech. Engrs.—Advance Paper for mtg. Dec. 2–6, 1929, 7 pp., 5 figs. Loeffler and Winterthur locomotives are described; former is express locomotive of 2500 hp. with pressure of 1470 lb. per sq. in.; 1200 hp. with boiler pressure of 850 lb. per sq. in.; it is expected to result in fuel saving of 40 to 45 per cent compared with modern superheated locomotives; in road test of Winterthur locomotive but 330 lb. of coal was necessary for firing up, as compared with double amount necessary for conventional locomotive of equivalent output.

Oil - Burning. Oil Burning Locomotives, 2–10–4 Type, Canadian Pacific Railway. Can. Ry. and Mar. World (Toronto), Nov. 1929, pp. 667–669, 4 figs. Low-carbon single steel is employed in crank pins and main and side rods; six cylinders, $25^1/_2$ by 32 in.; driving wheel 63 in.; locomotive weight in working order 452,500 lb.; wheel base 46 ft. $^1/_2$ in.; boiler pressure 275 lb.; locomotive tractive effort 77,200 lb.

Oil-Electric. Canadian National's 2600 Hp. Oil-Electric Locomotives. Ry. Mech. Engr., vol. 103, no. 10, Oct. 1929, pp. 574–577, 5 figs. Demonstration run made with eight-car train; locomotive, which is largest and most powerful of its kind consists of two units and weighs 650,000 lb. when fully equipped, of which 480,000 lb. is carried on driving wheels; each unit contains Bearmore 12-cylinder oil engine of solid-injection type, with cylinders of 12-in. bore and 12-in. stroke; nominal rating of engine is 1330 hp. at 800 r.p.m.; exhaust heat aids oil-fired boiler to heat train; selective data and dimensions of oil-electric and steam locomotives.

Steam-Turbine. The Steam Turbine Locomotive, J. MacLeod. Ry. Gaz. (Lond.), vol. 51, no. 17, Oct. 25, 1929, pp. 618–619, 2 figs.; see also abstract in Modern Transport (Lond.), vol. 22, no. 554, Oct. 26, 1929, pp. 3 and 5, 1 fig. Discussion of condensing and non-condensing turbine locomotives; general arrangement of geared steam-turbine non-condensing locomotive, 4 ft. $8^1/_2$ in. gage, express passenger 4-6-4 type; boiler pressure, 750 lb. per sq. in.; total steam temperature 750 deg. fahr.; tractive effort, 39,000 lb. train load, 600 tons; maximum gradient, 1 in 100; steam per drawbar hp. per hr., 12.5 lb.; coal per drawbar hp. per hr., 1.6 lb.

Abstract of paper before Instn. of Engrs. and Shipbldrs.

Valve Gears, Caprotti. Caprotti Valve Gears on Tender Locomotives (Caprottisteuerung an einer Tenderlokomotive), W. Bauer. V.D.I. Zeit. (Berlin), vol. 73, no. 39, Sept. 28, 1929, pp. 1398–1400, 10 figs. Reasons for selection of this type of gear by Krauss Co., Munich; differences between this and other valve gears from standpoint of heat engineering; savings in steam consumption with frequent startings and slightly inclined tracks.

LUBRICANTS

Cutting. Present Practice in the Use of Cutting Fluids, S. A. McKee. Am. Soc. Mech. Engrs.—Advance Paper, no. 59, for mtg. Dec. 2 to 6, 1929, 4 pp. Report is attempt to indicate trend or lack of trend toward use of particular type of cutting agent for given machining operation on given kind of metal; it is based on information obtained from 68 large users of cutting fluids in United States; list of number of plants using any of three general types of cutting agent (dry, water or emulsions, oils or oil mixtures) for each of 19 machining operations on eight kinds of metals; cutting agents used for various operations on given metal.

Greases, Zinc Oxide in. A Zinc-Containing Lubricant for the Prevention of Corrosion. Engineer (Lond.), vol. 148, no. 3846, Sept. 27, 1929, pp. 337–339, 7 figs. In running of device known as Keenok pinion, in which rapidly varying local stresses are set up, it was found that serious trouble was caused by corrosion of working parts; conclusion was reached that corrosion was electrolytic effect produced by rapidly varying local stresses to which parts were subjected; prolonged study was made of means to prevent corrosion; successful results were reached by employing as lubricant a grease with which considerable proportion of zinc oxide was mixed.

Oils, Properties of. Relation Between Physical Characteristics and Lubricating Values of Petroleum Oils, E. D. Ries. Indus. and Eng. Chem.—Analytical Edition, vol. 1, no. 4, Oct. 15, 1929, pp. 187–191, 3 figs. Preliminary report of work done thus far in projected experimental program of Chemical Engineering Laboratory of Pennsylvania State College; certain well-known material has been included for sake of outlining complete basis on which to evaluate lubricant; tests for physical characteristics are discussed in light of their relation to lubrication; plea for establishment of rational basis for evaluating lubricating oils.

LUBRICATION

Oil Films and Bearings. Oil Films and Bearings, H. Brillie and A. M. Robb. Engineer (Lond.), vol. 138, no. 3848, Oct. 11, 1929, pp. 382–384, 5 figs.; see also Shipbldg. and Shipg. Rec., vol. 26, no. 14, Oct. 3, 1929, pp. 405–406. Paper is based on work of G. Reynolds and suggestion that so-called "wedge formation" is not essential to maintenance of perfect film lubrication; expression is developed for giving actual thickness of oil film, or clearance between shaft and journal; outline of bearing for turbine machinery, based on considerations discussed is shown. Abstract of paper before Instn. Naval Architects.

Problems. Lubrication and Lubricants, R. M. Deeley. Engineer (Lond.), vol. 148, no. 3849, Oct. 18, 1929, pp. 405–407, 1 fig. Problem of lubrication is dealt with by first considering friction that occurs when two solid surfaces are in contact (adsorbed film lubrication), and then the state when they are entirely separated by viscous liquid (viscous film lubrication).

M

MACHINE TOOLS

Cutting Pressure on Tools. Apparatus for Measuring the Cutting Pressure Exerted on Tool Edges. Machy. (Lond.), vol. 34, no. 884, Sept. 19, 1929, p. 799, 3 figs. Description of special measuring instrument made by Losenhausenwerk, Duesseldorf-Grafenberg, by means of which three components of pressure exerted on cutting tool edges, may be accurately measured and recorded on chart; with this device turning tool rests on block connected to dial gages operated by hydraulic pressure; applications of measuring instrument to standard lathe; special drilling-machine testing table designed for testing machinability of materials by drilling.

Depreciation. What Obsolete Equipment Costs. Am. Mach., vol. 71, no. 19, Nov. 7, 1929, pp. 763–766, 1 fig. Study of savings effected by use of new tools in three electrical equipment manufacturing plants; three formulas mainly Warner and Swasey, SKF, and A.S.M.E. applied to three specific cases; eight operations performed on one turret lathe; major savings on minor parts; die savings pay for new machine.

Hydraulic Feeds. Hydraulic Feeds and Speeds, A. L. DeLeeuw. Am. Mach., vol. 71, no. 19, Nov. 7, 1929, pp. 774–776. Present practice and trend in use of hydraulic feeds and speeds in machine tools are discussed; theoretical advantages and disadvantages of hydraulic feed are taken up; means for overcoming difficulty in having entire feed come to standstill during certain period of time; it is possible to aid hydraulic feed by mechanical means in such a way that perfect timing is reached. Abstract of paper presented before World Eng. Congress.

MACHINERY

Welded, Design of. Welded Power Apparatus, H. V. Putnam and C. C. Brinton. Welding Engr., vol. 14, no. 10, Oct. 1929, pp. 46–49, 9 figs. Fundamental considerations involved in substitution of electrically welded fabricated steel parts for castings for engines, electric motors, and generators, vertical water-wheel generators, high-speed and low-speed d.c. generators and converters and turbo-generators; advantages in this type of construction; equipment needed for electric-cutting and arc-welding materials; tolerances allowed in fabrication of structural-steel parts; design of structural-steel parts; limitations of fabricated-steel construction.

Vibrations in. Vibrations of Machinery and Foundations (Maschinen- und Fundamentschwingungen). Elektrizitaetswirtschaft (Berlin), vol. 28, no. 492, Sept. 2, 1929, pp. 486–488. Brief review of causes and remedies of vibration in large machinery of any kind in modern practice; short notes on papers read before special convention of Verein deutscher Elektrizitaet Werke.

MATERIALS HANDLING

Automobile Plants. See AUTOMOBILE PLANTS.

Bakeries. Conveyor Equipment for Bakeries (I mezzi di trasporto nei pastifici), V. Zignoli. Organizzazione Scientifica del Laboro (Rome), vol. 4, no. 7–8, July-Aug. 1929, pp. 458–466, 13 figs. General schemes of conveyor systems of modern mechanized bakeries; features of belt conveyors, cages, skips, elevators, etc., for handling of flour sacks and dough.

Bulk Materials. Handling Bulk Materials, N. L. Davis. Matls. Handling and Distribution, vol. 1, no. 12 and 13, Sept. and Oct. 1929, pp. 36, 38 and 40, 32–33 and 80, 8 figs. Materials-handling operations are discussed for such bulk materials as grain, coal, iron, ore, limestone, gypsum rocks, sand and gravel, and metal ores.

Industrial Plants. Some Fundamental Principles of Materials Handling, H. V. Coes. Can. Machy. (Toronto), vol. 40, no. 21, Oct. 17, 1929, pp. 66, 68, 70 and 72. Cost of handling materials in two American industries; materials handling an important factor in determining plant layout in new industrial undertaking; principles of laying out materials-handling system; selection of equipment; question of whether return on investment is justified; rules for securing materials-handling economies.

Trends in Standardized Quality Production, J. H. Van Deventer. Am. Mach., vol. 71, no. 19, Nov. 7, 1929, pp. 777–779. Discussion of methods of gaining quality in mass production and how mechanical handling has been applied to attain it; machines grouped according to sequence; automobile production in two divisions; production creates consuming power; production development forces remodeling. Abstract of paper presented before World Eng. Congress.

Iron and Steel Plants. Materials Handling in a Structural Steel Fabricating Plant (Das Foerderwesen in einer Eisenkonstruktionswerkstaette), W. Meyer. Bautechnik (Berlin), vol. 7, no. 37, Aug. 27, 1929, pp. 589–596, 14 figs. Layout of plant fabricating structural steel members, with special reference to organization of conveyor system consisting of various types of platforms, overhead traveling cranes and elevators; statistics on operation and output of plant; cost data on operations; forms of records.

MAGNESIUM ALLOYS

Castings. A Note on Magnesium Alloy for Castings, E. Player. Aircraft Eng. (Lond.), vol. 1, no. 5, July 1929, pp. 175–178, 5 figs. Properties and practical processes in production of magnesium alloy castings are discussed with special reference to Elektron; foundry practice in regard to melting, molding, and core making of magnesium alloys castings; trimming; machine-shop practice; protection against corrosion; die-castings.

Temperature Effect. High-Temperature Compression and Extrusion Tests of Metals and Alloys (Les essais à chaud métaux et alliages par compression et par filage), A. Portevin. Revue de Métallurgie (Paris), vol. 26, no. 8, Aug. 1929, pp. 435–443, 9 figs. Results of tests carried out on magnesium and magnesium alloys at temperatures not exceeding 500 deg. cent.; extrusion tests were carried out on hydraulic press.

MALLEABLE-IRON CASTINGS

Annealing. Malleable Iron—Short Cycle Anneal, I. R. Valentine. Heat Treating and Forging, vol. 15, no. 10, Oct. 1929, pp. 1344–1345, 3 figs. Results of investigation made by General Electric Co. to learn something of mechanism of carbon precipitation and possibility for shortening annealing process; superior product with short time treatment is result of accurate temperature control; three 325-kw. electric furnaces, 11,000-volt primary 235-volt secondary installed; physical properties of malleable iron by regular annealing method and short-cycle method. Paper presented before Nat. Metals Congress.

Shortens Malleable Anneal. Foundry, vol. 57, no. 19, Oct. 1, 1929, pp. 825–826, 3 figs. Results of investigations conducted by General Electric Co. to learn something of mechanism of carbon precipitation with view of possible shortening of process; high temperature with quick drop to 740 deg. cent. decreases heat-treating interval to 28 or 30 hours.

METALS

Deep-Drawn Plate. Testing of Deep-Drawn Plate (Die Pruefung von Tiefziehblech), M. Schmidt. Archiv. fuer das Eisenhuettenwesen (Duesseldorf), vol. 3, no. 3, Sept. 1929, pp. 213–220 and (discussion) 220–222, 15 figs. Requirement of deep-drawn plates; determination of deep-drawing capacity on drawing press; practical determination of drawing limit; description of simple process and results obtained; comparison with other testing methods.

Fatigue of. Fatigue Failure of Machine Parts and Testing Methods for Determination of Durability (Ueber Dauerbrueche an Maschinenteilen und geeignete Prufverfahren zur Bestimmung der Dayerfestigkeit), E. Franke. Automobiltechnische Zeit. (Berlin), vol. 32, nos. 29 and 30, Oct. 20 and 31, 1929, pp. 643–645, and 676, 678, 9 figs. Causes for cracks in machine parts subjected to alternation of stresses are discussed; Woehler's testing method; Krupp impact testing machine for determination of resistance of materials; more recently, a dynamic bending machine with rotating test rod, made by Fa. Schenck, has come into use; torsion testing machine of same firm of Fa. Losenhausenwerk are also described.

The Fatigue of Metals—A Review of Progress From 1920 to 1929, H. F. Moore. Am. Iron and Steel Inst.—Advance Paper, for mtg., Oct. 25, 1929, 24 pp., 10 figs. Results of various investigations regarding fatigue of metals; determining endurance limit; short-time tests; repeated stress testing machines and specimens; effect of understress and overstress on fatigue strength; endurance limit and ratio; importance of localized stress; fatigue of metals at elevated temperatures; heat treatment and fatigue strength; corrosion fatigue; correlation between endurance limit and other physical properties; fatigue strength of cold-worked metal.

Machinability. Methods of Tests for Determining the Machinability of Metals in General, With Results, O. W. Boston. Am. Soc. Steel Treating—Trans., vol. 16, no. 6, Nov. 1929, pp. 659–694 and (discussion) 694–710, 54 figs. Results of experiments on 18 ferrous and 21 non-ferrous metals are presented to indicate best methods for determining whether or not material is suitable for machining purposes; it is shown that Brinell number varies almost directly with physical properties of these metals, such as ultimate strength in tension, compression, and shear, as well as Rockwell hardness number; scleroscope values, however, show independent relation.

Testing, Electric. Nondestructive Testing, E. A. Sperry. Am. Soc. for Steel Treating—Trans., vol. 16, no. 6, Nov. 1929, pp. 771–790 and (discussion), 790–798, 13 figs. Method of internal inspection is applicable to all metals and alloys; direct current of high amperage is passed through specimen and minute crack or inclusion produces deviation in axis of current flow, which is amplified to value suitable for operating recording equipment; method is used on railroads for detecting internal transverse fissures; it has been successfully adapted to inspection of new rails at mill, bars, tubes, axles, boiler plate, and welded joints.

MECHANICAL ENGINEERING

Research With Models. Research in Mechanical Engineering by Small-Scale Apparatus, F. C. Johansen. Instn. Mech. Engrs.—Jl. (Lond.), no. 2, Mar. 1929, pp. 151–271, 29 figs. Objects of paper are to review present position of research by small-scale apparatus; to suggest problems in mechanical engineering for which small-scale research appears to promise success; to refer, with brief descriptions, to existing examples of small-scale research in wide range of engineering subjects; and, most particularly, to evoke suggestions for improved methods and new lines of small-scale research in mechanical engineering.

N

NITRIDATION

Fundamentals of. A Few Practical Fundamentals of the Nitriding Process, H. W. McQuaid and W. J. Ketcham. Am. Soc. Steel Treating—Trans., vol. 16, no. 5, Oct. 1929, pp. 183–195 and (discussion) 195–203, 18 figs. Results obtained in attempting to determine effects of some factors of nitriding process on depth hardness curves as shown by Vicker's test; results indicate that heat treatment prior to nitriding is essential to obtain satisfactory toughness and resistance to shock load; decarburization is not necessarily detrimental to nitriding operation; tests made with tantalum to eliminate or reduce hydrogen on surface being nitrided indicate that hardness is decreased thereby.

Short-Time. Short Time Nitriding of Steel in Molten Cyanides, A. B. Kinzel and J. J. Egan. Am. Soc. Steel Treating—Trans., vol. 16, no. 5, Oct. 1929, pp. 175–179 and (discussion) 179–182. New development in nitriding is described whereby very hard thin case is obtained on articles made of vanadium or aluminum nitriding steel by immersion for two hours at 860 deg. fahr. in specially developed salt bath consisting of low melting solution of potassium and sodium cyanides; tests show that this case is as hard as that obtained with usual long-time ammonia treatment; it has same wear and corrosion resistance, although ability to withstand high local stress is less.

Special Steels. Influence of Nitrogen on Special Steels and Some Experiments on Case-hardening With Nitrogen, S. Satoh. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 260, 1929, 19 pp., 20 figs. Notes on tests, with current of ammonia gas at 580 deg. cent. and at 560 deg., on electrolytic iron, iron alloys, and specially prepared steels; effects of carbon, chromium, aluminum, titanium, manganese, molybdenum, zirconium, and of uranium; effect of nickel on penetration of nitrogen in electric arc welding. Bibliography.

Researches on Nitriding Steels, O. E. Harder, J. T. Gow and L. A. Willey. Am. Soc. Steel Treating—Trans., vol. 16, no. 5, Oct. 1929, pp. 119–139 and (discussion) 140–144, 38 figs. Study was made of considerable number of steels to determine their suitability for nitriding; nitriding temperatures used were 875 and 1000 deg. fahr.; effect of nitriding temperature, rate of gas flow, gas decomposition, etc., on character of nitrided case; hardness values were determined by Vickers instrument; chromium-aluminum steel was found to produce higher surface hardness than other steels studied.

NOISE

Instruments for Measuring. Determination of Noise Disturbances With Aid of Barkhausen Noise Meters (Pruefung von Geraeuschbelaestigungen mit Hilfe des Geraeuschmessers nach Barkhausen), E. Neitzel. Gesundheits-Ingenieur (Munich), vol. 52, no. 32, Aug. 10, 1929, pp. 575–577, 2 figs. Acoustic principles of design of so-called noise meters, to serve as guide for policemen in enforcing rules against unnecessary noise; review of studies of Barkhausen, Lewicki, and Tischner; features of Barkhausen noise meter and methods of its use; scale of noise intensities.

NON-FERROUS METALS AND ALLOYS

Annealing. Annealing of Non-Ferrous Metals, J. F. Schrumn. New England Indus. Elec. Heating Conference—Proc., June 1929, pp. 41–42. Selection of sources of heat for annealing of non-ferrous metals and alloys is economic problem and decision made should be based on overall cost of finished product with different forms of heat; experience of large Connecticut company manufacturing non-ferrous tubing, mainly brass and copper; electric furnaces of other mill using counterflow electric recuperative furnace of 150-kw. capacity, etc.; operation and performance data are given.

Hard Alloys. New Methods of Producing Especially Hard and Chemically Resistant Alloys (Neues Arbeitsverfahren zur Herstellung besonders harter und chemisch widerstandsfaehiger Legierungen). Zeit. fuer die gesamte Giessereipraxis (Berlin), vol. 50, no. 35, Sept. 1, 1929, pp. 139–141. Review of recent patented processes, including nickel-zirconium, nickel-tantalum, copper alloys, etc.

Research. Volume Changes During the Solidification of Metals and Alloys of Low Melting Point, W. E. Goodrich. Faraday Soc.—Trans., vol. 25, no. 101, Oct. 1929, pp. 531–569, 21 figs. Metals investigated consist of tin, lead, bismuth, and zinc; lead-tin and bismuth-tin alloys; antimony-tin alloys; lead-antimony alloys; tin-antimony-copper and tin-lead-antimony ternary alloys, and some typical zinc-base alloys containing copper and tin and copper and aluminum.

NOZZLES

Spray. Spraying (Ueber Herstellung von Schwebenden Fluessigkeitsnebeln mit grosser Oberflaeche). Chemiker-Zeitung (Koethen), vol. 53, no. 69, Aug. 28, 1929, pp. 671–672, 4 figs. Recent improvement in devices for increasing surface area of sprayed liquid mist is combined whirling and suction spray nozzle; type of nozzle has capacity range from 0.01 to 0.5 liter per min., operating at pressure ranging upward from 0.3 atm.; it may be operated by compressed air, steam, or gas; applications of nozzles include air conditioning, dust removal, removal of toxic matter from air or gases, spray drying, and acceleration of chemical reactions.

O

OIL ENGINES

Cylinder Pressures. Pressure Effects in Pre-Combustion Oil Engines, J. A. Polson and H. E. Degler. Power Plant Eng., vol. 33, no. 21, Nov. 1, 1929, pp. 1165–1168, 5 figs. Investigation of pressures in Hvid type oil engine discloses conditions affecting power and efficiency; operation of engine; method of conducting tests; diaphragm indicator used for later tests; results and conclusions; several operating charts are given.

P

PIPE BENDS

Reduction of Losses in. Reduction of Losses in Square Pipe Bends (Verlustverminderung in rechtwinkligen Kruemmern). Waerme (Berlin), vol. 52, no. 42, Oct. 19, 1929, pp. 792–793, 4 figs. Based on numerous and detailed tests on rectangular pipe bends, data are presented on velocity distribution, pressure curve, and losses; it is claimed that losses due to change in direction of flow can be reduced to minimum by shape which deviates from that of standard bends.

POWER PLANTS

Combined Steam and Hydroelectric. Combined Hydro and Steam Power Plants (Die Vereinheitlichung von hydrokalorischen Verbundbetrieben), M. Seidner. Elektrotechnische Zeit. (Berlin), vol. 50, no. 42, Oct. 17, 1929, pp. 1523–1524. Conditions are outlined by which hydroelectric plants with continuous daily, and annual storage should be combined with steam plants to compound units in order to obtain greater economy and least production costs.

Industrial, Cost Accounting in. Classification of Costs for Industrial Power Plants, W. N. Polakov. Power, vol. 70, no. 15, Oct. 8, 1929, pp. 558–560. Accurate knowledge of power costs is vital to efficient plant management, and necessary to any analysis of manufacturing cost; classification of power-plant expense which should serve as helpful guide in any specific instance; power-plant expense classification.

PULVERIZED COAL

Combustion. Combustion of Pulverized Coal (La Combustion du Charbon Pulverisé), J. Lacasse. Arts et Métiérs (Paris), vol. 82, no. 106, July 1929, pp. 254–260, 11 figs. Problems in burning pulverized coal are discussed; turbulent combustion chambers; results established by tests and confirmed by practice with regard to excess air and percentage of carbon dioxide; behavior of combustion in different types of combustion chambers; Bailey design of combustion chamber; Hydrojet system for removing ashes; modern installation is described.

Influence of Particle Size on Rate of Combustion of Coal Dust (Einfluss der Korngroesse auf die Entzuendbarkeit von Kohlenstaub), H. Steinbrecher. Archiv. fuer Waermewirtschaft (Berlin), vol. 10, no. 10, Oct. 1929, p. 350. It is claimed that in mixtures of particle sizes of air-dried dust of most widely different coals in stored as well as in suspended state, not finest part, but mean fraction has greatest combustion rate; in case of completely dried lignite dust, finest particle mixture ignites in stored state most rapidly.

PUMPING STATIONS

London. The Kempton Park Pumping Station of the Metropolitan Water Board. Engineering (Lond), vol. 128, nos. 3325 and 3326, Oct. 4 and 11, 1929, pp. 425–427 and 470 and 455–458, 15 figs. partly on supp. plates. Oct. 4: Account of addition consisting of complete pumping plant, and set of primary filters; water is derived from River Thames; arrangements of bunkers and coal and ash-handling plant. Oct. 11: Arrangement of engine house; pumping machinery, constructed by Worthington-Simpson, consists of two vertical triple-expansion engines each of over 1000 pump hp.; battery of 24 rapid gravity filters is being constructed in reinforced concrete.

PUMPS

Screw. Testing of Screw Pump With Spiral Casing Made by Deutsche Werke Kiel. A.G. (Beproeving van een schroefpomp met slakkenhuis der Deutsche Werke Kiel A.G.), W. L. H. Schmid. Ingenieur (The Hague), vol. 44, no. 37, Sept. 14, 1929, pp. W.172–W.180, 10 figs. Test results; brief derivation of principal equation for turbine pumps; analogy between characteristics of a turbine pump of various speeds; these can be combined into one uniform characteristic; transformation of kinetic into potential energy in housing; explanation of violent eddying of suction water, etc.

PUMPS, CENTRIFUGAL

Efficiency. Calculations of Efficiency Coefficient of Centrifugal Pumps (Foerutberaekning av verkningsgraden hos centrifugalpumpar), H. O. Dahl. Teknisk Tidskrift (Stockholm), vol. 59, no. 33, Aug. 17, 1929 (Mekanik), pp. 101–105, 3 figs. Considering different losses in pumps, author shows method of computing efficiency and illustrates its use in four examples.

Problems. Engineering Problems of Centrifugal Pumps in Thermal Electric and Hydroelectric Plants (Problemi tecnici inerenti alel pompe centrifughe per gli impianti termo ed idroelettrici attuali), M. Medici. Energia Elettrica (Milan), vol. 6, no. 5, May 1929, pp. 469–483, 26 figs. Cavitation and corrosion in boiler feed pumps, turbo-pumps and turbines are discussed; European and American experience reviewed.

R

RAIL MOTOR CARS

Gasoline-Electric. Brill's New Rail Car Engines Among the Largest Produced. Automotive Industries, vol. 61, no. 17, Oct. 26, 1929, pp. 621–624, 6 figs. Description of two new power plants, one six-cylinder and other eight-in-line, of similar design, developing 400 and 535 hp. respectively, developed by J. G. Brill Co., Philadelphia; eight-cylinder equipment described in detail; in addition to main engine, small automotive-type four-cylinder engine of 15 hp. is used to drive 32- to 40-volt generator having continuous rating of 7.5 kw., for battery charging and other purposes; low-voltage circuit diagram given.

REFRIGERATION

Evaporating Systems. The Multi-Feed Multi-Suction Evaporating System, G. Hilger. Ice and Refrigeration, vol. 77, no. 5, Nov. 1929, pp. 344–345, 2 figs. Description of constructive details of new evaporating system for ice-making and refrigerating plants; also description of system installed in large dairy in Pittsburgh; list of applications of system in various parts of country; illustration showing essential features of multi-feed multi-suction evaporating system.

ROLLING MILLS

Anti-Friction Bearings. Special Study Regarding Lubrication of Anti-Friction Bearings on Mill and Crane Motors, F. D. Egan. Iron

and Steel Engr., vol. 6, no. 7, July 1929, pp. 415–417. Questionnaire and replies are given which were circulated among industry by special committee on bearings to secure knowledge regarding general practice in lubrication of anti-friction bearings; replies indicate wide diversity of opinion on subject and make it almost impossible to formulate definite set of rules to suit all conditions.

Electric Drive. Two-Motor Direct Drive for Blooming Mill. Iron Age, vol. 124, no. 18, Oct. 31, 1929, p. 1178, 1 fig. Description of 10,000-hp. twin-motor direct drive for blooming mills which has been installed by Illinois Steel Co. in its South Works for 54-in. blooming mill; equipment includes two 5000-hp. of 40 to 80 r.p.m. speed, 9000-kw. motor generator having 6500-hp. driving motor and 180,000-lb. 15-ft. diam. steel-plate flywheel and necessary control apparatus.

Magnetic Tables. Magnetic Tables to Handle Steel. Iron Age, vol. 124, no. 19, Nov. 7, 1929, pp. 1247–1248, 3 figs.; see also Iron Trade Rev., vol. 85, no. 19, Nov. 7, 1929, pp. 1179–1180, 3 figs. Description of cooling bed for handling steel bars and of shear approach table of magnetic type developed by W. McKee; bars, pipe, and other sections pulled along by magnetized rollers; long geared shaft omitted; table with magnetic roller just installed by Ohio Mills for handling electrically welded pipe; balanced hot bed, delivering to either side.

Practice. Recent Tendencies in Rolling-Mill Practice (Neuzeitliche Bestrebungen im auslaendischen Walzwerksbetrieb). Stahl und Eisen (Duesseldorf), vol. 49, nos. 37, 38, and 39, Sept. 12, 19 and 26, 1929, pp. 1334–1339, 1370–1378, and 1405–1409, 35 figs. Brief historical review of developments in rolling mills for wire, semi-finished products, strip, etc.; blooming mills in combination with continuous mills for semi-finished products; Garrett and continuous wire mills; rolling mills for special steels; semi-continuous mills, etc.

Roll-Pass Design. Roll Pass Design, W. Trinks. Rolling Mill Jl., vol. 3, nos. 9 and 10 Sept. and Oct. 1929, pp. 399–402 and 425–430, 11 figs. Sept.: Factors affecting amount and distribution of lateral spreading are discussed; shape of projected contact area; friction between bars and rolls; speed of rolling. Oct.: Effects of shape of pass and temperature on amount and distribution of lateral spreading of bar in rolling.

S

SCREWS

Cold Heading and Thread Rolling. Cold-Heading and Thread Rolling, F. R. Daniels. Iron Age, vol. 124, no. 16, Oct. 17, 1929, pp. 1027–1028. Characteristics of steel wire best suited to cold heading and thread rolling in making bolts, screws, and rivets are discussed; importance of adequate drawing; wire finish for bolts, screws and rivets; temper is heavy factor; heat treatment of cold-headed blanks; numerous analyses suitable for cold heading and threading in alloy steel field.

SEAPLANES

Design. Seaplane Design, T. P. Wright and G. A. Luburg. Aviation Eng., vol. 10, no. 2, Oct. 1929, pp. 32–35. Seaplane operation, although confined to sea and waterways, commercially can compete to great extent with that of land plane; requirements for float or hull design, including seaworthiness at rest or at anchor, seaworthiness and stability when underway, low water resistance and absence of suction, clean lines, proper free board and excess buoyancy, and aerodynamic cleanness; arrangements of floats; design of step location, bow, stern, bottom deck, and hydrovanes; structural composite arrangement. Abstract of paper presented before Am. Soc. Mech. Engrs.

Dornier Do-X. The Monster Dornier Do-X, J. H. D. Blanke. Aeronautics, vol. 5, no. 4, Oct. 1929, pp. 42–43, 2 figs. Distribution of German experiment in gigantic air cruisers; Dorner Do-X monoplane seaplane with 157.4-ft. wing span and 12 Siemens-Jupiter engines mounted in tandem; developing total of 6300 hp.; wings fastened laterally to top of hull are additionally joined by three struts to combined stub wings and floats projecting from hull, a design claimed to give great lateral stability and to reduce take-off run; 150 m.p.h. top speed.

Launching. A Rival to the Catapult. Aeroplane (Lond.), vol. 37, no. 10, Sept. 4, 1929, pp. 653–654, 3 figs. Kiwull Watersail method of launching and picking up seaplanes, which can be used when vessel is under way, is briefly described; Watersail is 98 by 32 ft. expanse of canvas with spreader booms on underside and kind of drogue of wide-mesh netting; plane taxis behind steamer and is run onto trailing runway.

SHEET METAL

Testing Machine for. Sheet Metal Testing Machine. Engineering (Lond.), vol. 128, no. 3327, Oct. 18, 1929, p. 497, 4 figs. Tool has been introduced by W. and T. Avery, for testing quality of metal sheets intended for press work, or alternatively for controlling annealing of metal sheets of every description; tester can, if required, be used for mild sheets as much as 10 B.G. thick, but makers recommend that, in general, steel sheets to be tested should not be more than $^1/_{16}$ in. thick.

STEAM CONDENSERS

Surface. Alignment Chart for Calculation and Analysis of Surface Condensers (Nomogramm zur Berechnung und Beurteilung von Oberflaechnkondensatoren), H. K u e g n e. Waerme (Berlin), vol. 52, no. 37, Sept. 14, 1929, pp. 716–719, 2 figs. Plotting and description of nomogram for direct determination of performance of surface condensers.

Condensing Equipment. Nat. Elec. Light Assn.—Serial Report, Aug. 1929, 35 pp., 33 figs. Study of data received, corrected to common basis of water velocity and inlet water temperature, indicates that performance of single-pass condensers is somewhat better than that of two-pass type; performance of vertical condensers is appreciably better than horizontal condensers with same number of passes; tables and performance data for 15 two-pass and 11 single-pass condensers; leakage resulting from tube vibration has been most effectively remedied by installation of additional tube support sheets and by use of thicker tubes.

STEAM-ELECTRIC POWER PLANTS

Design. Trends in Design of Electric Superpower Plants (Les tendances actuelles dans la construction des supercentrales électriques), L. Le Paige. Revue Universelle des Mines (Liége), vol. 72, nos. 4, 5, and 6, Aug. 15, Sept. 1, and Sept. 15, 1929, pp. 107–111, 144–156, and 173–182, 17 figs. Developments in Europe and United States; capacity of modern plants; fuel economy; guaranteed consumption of modern European turbines from 10,000 to 43,500 kw.; mechanical stokers; economizers and air heaters; boiler equipment; pipe lines; feedwater and water treatment; details of existing plants in United States and Europe.

Detroit, Mich. New 100,000 Kw. Delray Power Plant Placed in Operation, F. J. Chatel. Power, vol. 70, no. 19, Nov. 5, 1929, pp. 710–715, 6 figs. General description of equipment in new Delray power house No. 3; standard 50,000-kw. units installed; main unit auxiliaries; illustration showing cross-section through boiler house; 15-retort 57-tuyere underfeed stokers.

Evansville, Ind. Ohio River Station. Power Plant Eng., vol. 33, no. 21, Nov. 1, 1929, pp. 1148–1154, 8 figs. New 400-lb. station of Southern Indiana Gas and Electric Co. has initial capacity of 20,000 kw. in two units; steam supplied by two 1152-hp. boilers fired by underfeed stokers; draft and furnace arrangements give extremely flexible control; coal has equipment enclosed to eliminate dust; cross section through station showing boiler, turbine and auxiliary arrangement; all auxiliary motors operate on 4400 volts; list of equipment installed in Ohio River station.

STEAM ENGINES

Efficiency. Thermic and Thermodynamic Efficiency Factor of Steam Power Machinery (Thermischer und thermodynamischer Wirkungsgrad von Dampfkraftmaschinen), G. Zerkowitz. V.D.I. Zeit. (Berlin), vol. 73, no. 40, Oct. 5, 1929, pp. 1429–1433, 7 figs. Graphical mathematical analysis.

STEAM HEATING

Saturated vs. Superheated Steam. Superheated vs. Saturated Steam for Heating Systems (Heissoder Sattdampf fuer Heizungsanlagen?), F. Kaiser. Zeit. des Bayerischen Revisions-Vereins (Munich), vol. 33, nos. 15, 16, 17 and 18, Aug. 15, 31, Sept. 15 and 30, 1929, pp. 216–218, 233–237, 249–252 and 259–263, 6 figs. Aug. 15: Notes on steam and surface temperatures. Aug. 31: Heat emission from different parts of heating element Sept. 15: Results of steam measurement in cookers, drying and heating plants, etc. Sept. 30: Comparison of results with other researches; conclusions.

STEAM PIPE LINES

High-Pressure. Construction of Steam Pipe Line of 44 Kg. Pressure and 450 Deg. Temperature (Note sur une exécution de tuyauterie de vapeur à 44 kilogrammes et 450 degrès), F. Battestini. Bull. Technique du Bureau Veritas (Paris), vol. 11, no. 8, Aug. 1929, pp. 173–174, 1 fig. Particulars of installation at power plant of Issy-les-Moulineaux, France; fatigue testing of tubes; properties of steel employed; use of welded joints.

Testing of Material Used in Piping for High-Pressure Steam (Essais des matériaux employés dans les canalisations de vapeur à température élevée), L. Guillet, J. Galibourg and M. Samsoen. Revue Générale de l'Électricité (Paris), vol. 26, no. 15, Oct. 12, 1929, pp 577–580, 3 figs. Elasticity meter, which is used for keeping temperature of test piece constant at 450 deg. cent., is described; results of tensile-strength tests on nickel and chromium-nickel steels.

T

TORSION TESTING

Foettinger Torsionmeter. The Foettinger Torsionmeter. Engineering (Lond.), vol. 128, no. 3328, Oct. 25, 1929, pp. 542–543, 2 figs. Indicator rotates with shaft and its dial, being brightly illuminated by proper shaded electric lamp which moves with it; there is, it is stated, no difficulty whatever in taking readings whether shaft be running fast or slow; sleeve disk and drum are all made of aluminum so that even largest sizes of torsion meter is of moderate weight; it is made in nine standard sizes.

TUBES

Seamless, Manufacture of. Germany Extruding Seamless Tubes of Stainless Steel, W. Trinks. Iron Age, vol. 124, no. 18, Oct. 31, 1929, p. 1160. Marked development in making of seamless tubes in Germany discussed; Mannesmann Tube Co. extrudes seamless tubes up to 3-in. in diam. of stainless steel; several expanding mills being developed; Mannesmann Co. has mill similar to Stiefel expanding mill but uses tension mandrel; new piercing mill; rolling from large hollow ingots. Abstract of paper presented before Am. Soc. Mech. Engrs.

V

VIBRATIONS

Measurement of. Investigations on Vibrations and Sounds (Untersuchungen ueber Erschuetterungsschwingungen und Geraeusche), H. Gerdien, H. Pauli, and F. Trendelenburg. Zeit. fuer Technische Physik (Leipzig), vol. 10, no. 9, 1929, pp. 374–378, 10 figs. Communication from Research laboratory of Siemens and Halske and Siemens and Schuckert, on tests carried out by electric method. Report of Research Laboratory of Siemens Halske and Siemens Schuckert.

W

WAGES

Wage-Payment Plans. Incentive Wage Systems, H. K. Hathaway. Taylor Soc.—Bul., vol. 14, no. 5, Oct. 1929, pp. 196–205. Presentation of fundamental principles that underlie classes into which various pay systems may be logically grouped; objects that each class is intended to accomplish; vast difference that exists between class advocated by Taylor and his associated and all others.

This Group Wage Plan Has Individual Incentive, H. G. Perkins. Mgmt., vol. 33, no. 4, Oct. 1929, pp. 43–46 and 78–80, 2 figs. Description of system used by Kelvinator Corp., Detroit, Mich., manufacturer of electric refrigeration.

WOOD PRESERVATION

Bakelizing. New Process for Perfectioning of Wood, Bakelization (La Bakélisation), M. Texier. Société des Ingénieurs Civils de France—Bul. (Paris), vol. 82, no. 34, Mar.-Apr. 1929, pp. 277–281. General properties of wood and various process for its improvement for industrial use; bakelization process and properties of wood so treated compared with original wood is shown in tables and curve; test report of insulator pin of bakelized wood; use of bakelized wood in electric-line construction.

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IN TWO SECTIONS—SECTION TWO

MECHANICAL ENGINEERING

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What It's All About

THE January issue of MECHANICAL ENGINEERING is devoted to the Annual Progress Reports of the A.S.M.E. Professional Divisions. The following excerpts from these reports indicate the nature of their contents. No engineer should fail to read these statements of progress.

Aeronautics

THE radial air-cooled engine is still the most widely manufactured and used, but it is being pushed in the low-horsepower class by air-cooled in-line engines. . . . The most efficient cooling medium for engines was found to be ethylene glycol, which can be used with a jacket outlet temperature of 300 deg. fahr. . . . Outstanding power-plant developments are the development of the use of the venturi type of cowling and the increasing use of geared engines. . . . The tendency has been toward the monoplane rather than the biplane. . . . There has been an increasing use of duralumin, and of the corrosion-resisting alloy Alclad. . . .

The air-cooled engine ranging in power from 200 to 600 hp. is standard in Navy planes. . . . In Nicaragua, six tri-motored transport planes have been in daily use in every sort of weather over rough, wild country. . . . Progress on the Navy's lighter-than-air program is marked by the beginning of construction of the first of the two 6,500,000-cu. ft. dirigibles *ZRS-4* and *ZRS-5*, and by the completion of the *ZMC-2* (metalclad) airship. . . . The steel-tubing structure has proved more satisfactory in every way, and appears to offer a surprising amount of protection to the crew in event of a crash. . . . A trapeze for carrying, releasing, and hooking on airplanes has been installed and successfully tested on the *Los Angeles*. . . . A careful inspection of many of the nation's largest air-ports will probably disclose the fact that many of them are "white elephants."

CHARLES PIEZ
PRESIDENT, A.S.M.E., 1930

Fuel Utilization

IT HAS been demonstrated that steam may be produced consistently at an efficiency of 90 per cent. . . . A 5000-bbl.-per-day hydrogenation plant is now under way. . . . There has been an enormous increase in the utilization of natural gas, a decided increase in coke-oven-gas production, a decrease in water-gas production, and a continual increase in the number of waterless holders for the storage of gas at relatively low pressures. . . . The outstanding feature of a majority of recent boiler installations is the almost universal use of furnace-wall cooling by means of air or water, with the trend apparently in favor of the latter. Fears of incomplete combustion due to cooling of the reacting products have not been realized. . . .

A keener competition between stokers and pulverized-coal firing is reported, the stokers regaining some of the lost ground. . . . The use of air preheaters as a final heat-absorbing medium is widespread, and consequently stokers have had to be adapted for use of preheated air. . . . The most practical heat-liberation rates are still 12,000 and 25,000 B.t.u. per cu. ft. per hr. . . .

Roller mills and ball mills are more extensively used for pulverization than other types. . . . Experiments have continued on the problem of the marine use of pulverized fuel, and in most cases have been highly successful. . . . An oil-burning locomotive of the Kansas City Southern Railroad has been equipped with a unit system of pulverized-coal firing and has given excellent results. The fuel consumption is 25 per cent less than with a similar hand-fired furnace, the steaming capacity is equal to that of an oil-fired boiler, and the fuel cost is only 40 per cent of the cost of oil firing.

Hydraulics

THE discovery and development of an important natural-gas field in central California has made it possible to produce steam power in gas-fired installations at a lower cost than previously obtained with oil-fired boilers and many hydroelectric plants . . . . Recent investigations by means of telemeters imbedded in large concrete masses, such as dams, have revealed the existence of high local temperature stresses. . . .

In the field of hydraulic machinery, the most notable development has been the installation at the Devil's River plant, in Texas, of a Kaplan-type high-speed turbine whose blades are adjustable by means of the governor. . . . A 44,000-hp. Pelton turbine, operating under 715 ft. head, showed a maximum efficiency of 93 per cent. . . . Recent advances in welding have made it possible to produce arc-welded plate-steel scroll cases, which combine the interior smoothness and streamlines of cast-metal scroll cases with the strength of steel. . . .

Industrial Management

THE elimination of waste in industry is taking a new turn. Besides the waste of concrete materials resulting from overdiversification and other causes, there is a tremendous waste through the use of inefficient processes for the production, transmission, and utilization of energy.... Another tendency is the realization that conservation and efficient utilization of resources apply to man-made as well as to natural resources.

The improved and wider usage of budget systems is a definite step of management progress....Management can be truly efficient only if the thing managed is efficient in itself.

A tendency has been developing to make more and more group applications of incentive plans....Experience is showing that the mathematical relation between obsolete machinery and profits is an inverse ratio.

With few exceptions, industrial executives are in favor of such dimensional standards as will permit mass production, and of quality specifications for the materials purchased by them.

Relatively little progress has yet been made in analyzing distribution costs from the standpoint of the cost of handling individual items or performing individual services. . . . Saving is only a minor part of real waste elimination.

Iron and Steel Industry

A WIDE-HEARTH blast furnace with a hearth diameter of 24 ft. 6 in. and a bosh of 26 ft. 3 in. is said to have produced a daily average output of 1008 tons.... Blast-furnace gas is now being used satisfactorily at coke ovens, thereby releasing the coke-oven gas for other purposes. . . . The industry can confidently look forward to practical suggestions for improvements in practice in the bessemer process. . . . A mill built for the Sharon Steel Hoop Company rolls strip from $2^1/_2$ in. to 10 in. wide at speeds up to 2400 ft. per min. in coils of from 150 lb. to as high as 2000 lb. . . . It has been announced that experimental work on the centrifugal casting of guns leads to the belief that the process has been satisfactorily established for the 37-mm. gun, the 75-mm. infantry mortar, and the 75-mm. howitzer. . . . A significant development is the tendency of American manufacturers to take out licenses under patents originating in Germany.

Machine-Shop Practice

THE tendency in machine design is away from the single-purpose machine. For high production and very special work the single-purpose tool, of course, will always find a market. . . . There is a definite tendency toward a more extensive use of hydraulic mechanisms on numerous types of machine tools. . . . Increasing attention to lubrication is evidenced by the equipment developed during the year.... The most important single development of the year has been the progress made in adapting the new tungsten carbide cutting tools to machine-tool uses.... There has been considerable disappointment at the failure of this new cutting material to solve all the difficult machining problems of the shop, but much of this disappointment is entirely unjustified, and should not lead potential users to distrust its future possibilities. An interesting effect of the introduction of tungsten carbide has been the improvement in high-speed steels.

Materials Handling

THE increase in the cost of common labor compelled the manufacturers of clay products to seek mechanical methods so that the cost of their products would not become prohibitive. . . . Gasoline tractors have been designed which have the approval of the insurance companies for use under packing-house conditions. . . . The newly developed high-lift truck for the purpose of icing dining cars makes it possible for two men to ice 18 cars in $2^1/_2$ hours, whereas it formerly took 6 men 8 hours each to ice 15 cars. . . .

A truck, the battery of which is mounted above the deck directly over the front wheels next to the dash, thus acting as a counterweight for the overhung loads, has been developed. . . . At Barranquilla, Colombia, S. A., it has been found that, in spite of the very cheap native labor, two trucks which are used for handling freight have been paying for themselves every three months. . . . A new truck, known as the foot-lift truck, enables the operator to elevate the load by using the full weight of his body, rather than calling into play his back and stomach muscles, which are used when the load is elevated with the steering handle. . . . A rapid and extensive use of conveyor-type systems for electroplating and deposition of metals has been reported. . . . The materials-handling installation made at a crankshaft forge shop is among the first attempts to put forge-shop production on a continuous basis.

Oil- and Gas-Power Engineering

RECENT oil-engine developments have been revolutionary. During the last year oil engines of two widely different designs "went up in the air" in airplanes; a large British airship propelled with oil engines has been commissioned; a 24,000-hp. stand-by and peak-load stationary power plant was recently started; a battleship with a 50,000-s.hp. propelling plant has been laid down; and for the 100,000-hp. power plant of the new electrically propelled White Star liner, oil engines are being seriously considered. The principal reason for much of the progress has been the development of means to materially reduce weight and space requirements of oil engines. Higher piston and rotative speeds, airless injection of fuel, supercharging of four-cycle engines, double-acting cylinder construction, special types of frames, and improved materials have contributed to each individual success.

Petroleum Industry

SEAMLESS line pipe has been used extensively for welded pipe lines. . . . A welded line 200 miles in length was tested without a failure, and no failures have occurred during its two years of service either in the pipe or in the oxyacetylene welds joining the pipe. . . . The most marked development has been the use of electric welding for the joining of pipe together in the case of trunk lines. It is known now that the gas-welded line is reliable, and it is believed that the electrically welded

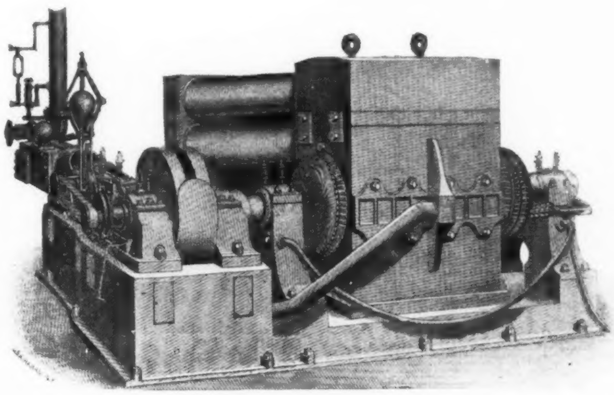
line will prove likewise. . . . The use of the electric motor for pipe-line pumping stations has brought about the possible use of automatic control. . . .

The pipe lines built recently have been designed to make use of a smaller amount of tankage at the pipe-line stations located along the trunk lines. . . . Experimental work is being carried out on the use of all-aluminum and part-aluminum tanks in sizes up to 1000 bbl. to eliminate the corrosion caused by the vapors from the oil produced in West Texas. . . . Eighty thousand barrels is becoming a standard refinery size for gasoline storage. . . . By the introduction of hydrogen under pressures of from 1400 to 4200 lb. and in the presence of a catalyst, it is now possible to convert practically all of the original oil into gasoline and other products.

Printing Industries

THE teletypesetter is the latest development in the field of setting type by mechanical means. It extends the usefulness of the casting machine and amplifies the means by which news may be transmitted quickly from a central point. . . . In modern high-speed rotary presses, the potential speed cannot be fully reached because of the limitation imposed by uneven or unbalanced rolls of paper. . . . There is now no question that air humidification and air control are becoming more and more necessary adjuncts to the printing industry. . . .

A newspaper rotary printing press for a midwestern daily paper has an hourly capacity of 400,000 printed and folded newspapers up to 16 pages. . . . A new color press has been brought out which will print up to five colors on a sheet in one passage through the press. . . . Carborundum paper has been used in place of the usual manila as a packing for impression cylinders on high-speed web presses.



THE EDISON STEAM DYNAMO

(This 1200-light machine, reproduced from a wood engraving in the A.S.M.E. Transactions for 1882, was described to the Society in that year by Mr. Charles T. Porter who built the steam engine to drive Edison's bipolar electric generator.)

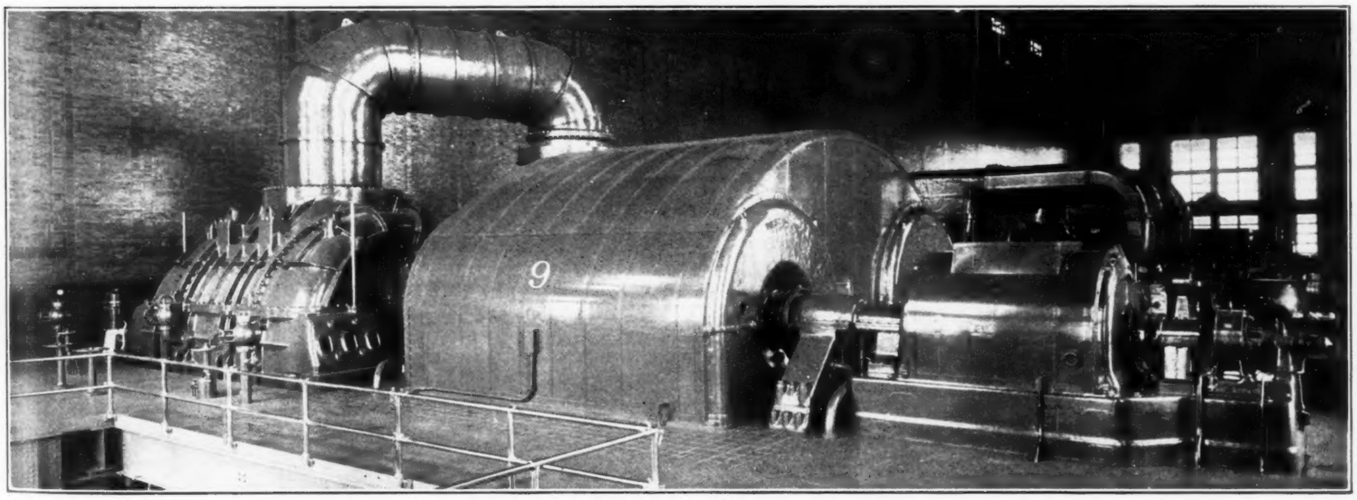
Railroad Mechanical Engineering

CONTINUED growth of passenger travel by highway buses has led the railroads to enter this field more extensively and to coordinate train and bus service. . . . After experience with two locomotives operating at pressures of 350 and 400 lb., the Delaware & Hudson has placed an order for a third which will carry 500 lb. boiler pressure. . . . The Canadian National Railways have placed in service the most powerful oil-electric locomotive ever built. Two units make up the complete locomotive, which weighs 650,000 lb. Motive power is provided by two 12-cylinder Beardmore high-speed solid-injection oil engines rated at 1330 hp. at 800 r.p.m. The fuel consumption of the engines is 0.43 lb. per hp-hr. . . .

The most noteworthy locomotive of the standard type built during the past year was the single-expansion articulated 2–8–8–4 designed for the Northern Pacific, the largest and most powerful steam locomotive in the world. The total weight of engine and tender is 1,116,000 lb. The tractive force of the main engines at 70 per cent cut-off is 139,900 lb., with 13,400 lb. additional developed by the booster.

Steam-Power Engineering

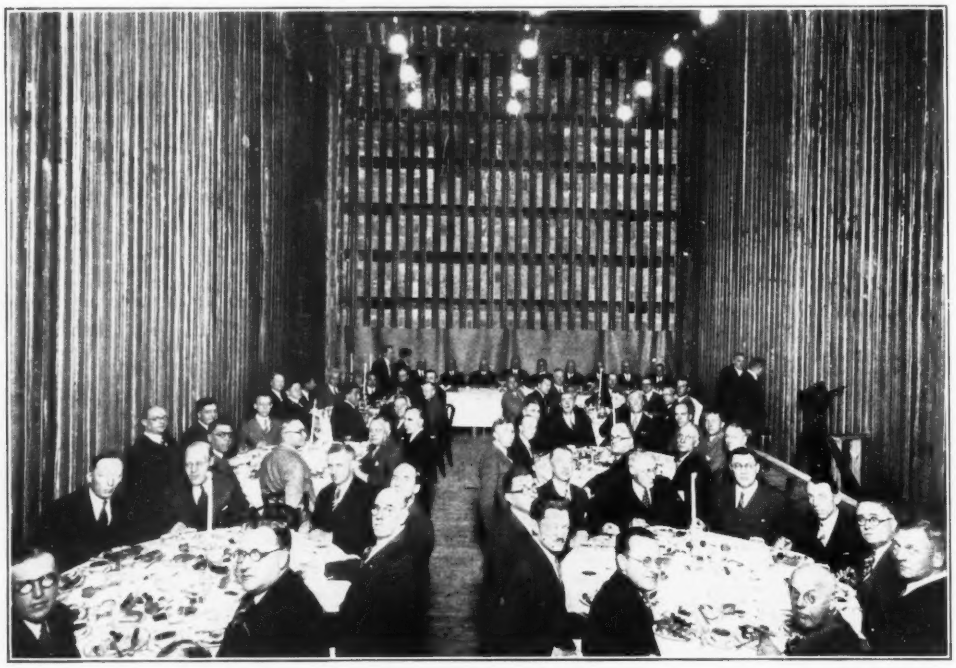
THE year has witnessed larger mergers of invested capital, larger interconnections of central stations,



165,000-Kw. TURBO GENERATOR

(Contrast this machine with the Edison steam dynamo built 47 years ago. Mr. Porter reported a test in which 1375 lamps were lighted, the engine developing 168.4 hp. The steam dynamo was designed for "the Edison station of the first district of New York City." The turbo generator was designed for the Hell Gate Station, also in New York City.)

larger industrial heating loads as well as larger power loads diverted to central stations, larger stations, larger equipment units, and larger demands for electrical power. . . . The most outstanding developments in boiler-plant equipment are the rapidly increasing capacity and continuity of service of steam-generating units. . . . In stations with a high load factor there has been an increase in the number of plants designed for steam pressures of approximately 1400 lb. . . . There has been no trend toward higher steam temperatures except for experimental purposes, and though designers have preferred greater reliability and less efficiency at 750 deg. fahr. (and probably will until less expensive materials are available), there are positive indications that higher temperatures will be used in the near future. . . .



LUNCHEON FOR 91 INSIDE A BOILER

(Prior to firing one of the new pulverized-coal boilers at the East River station of the New York Edison Co., a luncheon for 91 was served inside the combustion chamber, a temporary floor, 23 ft. 6 in. by 43 ft. 6 in. being laid. This boiler, guaranteed to deliver 800,000 lb. of steam per hour, is reported to have a capacity in excess of one million pounds.)

Feedwater heating shows an apparent trend toward the more effective use of the regenerative cycle. Never in the history of the profession has feedwater treatment been given so much attention. . . . The growth of power systems has made larger turbine installations economically possible. . . . Recently designed stations indicate a decided increase in the use of single-pass condensers. . . . Exchange of power between central stations and industrial plants is gaining in favor.

Textile Manufacturing

THE year has shown a marked improvement in the attitude of textile-mill owners toward the adoption of better machinery and methods, thus creating an increased demand for trained men from textile and engineering schools. This interest in scientific methods has created a demand for more and better equipment for the testing of materials at various stages of manufacture. . . . There is a growing appreciation of proper humidity and its accurate control. . . . Marked increase in the output of rayon is worthy of note. A near approach has been made to real silk, both in fineness and appearance. Other properties have been improved, resulting in greater resistance to heat and better affinity for dyes. Hosiery made entirely of rayon is now a fact, and rayon sewing thread has been placed on the market. . . .

The outstanding development in spinning is the application of variable speed to the spindles. . . . The automatic loom has been improved by constructing it heavier and by using anti-friction bearings for the main journals. . . . There is a tendency toward a greater use of the electric types of stop motion since these have been improved over the older electric devices . . . . With the growing demand for color, new dyes have been introduced which give brighter colors, dye more successfully in neutral baths, and are better able to withstand hard wear. . . . Today a wool fabric must be finished, ready for the needle; there must be practically a permanent set not affected by the steam pressing now almost universally used by clothiers. . . . The production of heavy knitted fabrics closely resembling the woven product has caused no little interest and speculation in the textile field.

Wood Industries

SHORT-LENGTH lumber is becoming sufficiently important to justify the construction and use of special machinery for using it in manufacture. . . . Automatic ejectors for use with wood-turning lathes are being used. High-speed motorized machines are being fitted with automatic electric stopping brakes for cutterheads. . . . The grade marking of lumber is becoming a regular practice. . . . There has been a great increase in the use of "wood flour" for the manufacture of Bakelite and similar composite materials. . . .

New activities include: Furniture shipping in plywood boxes instead of crates; an enormous increase in the use of plywood for the construction of radio cabinets; the gradual but steady transformation of the so-called "sash-and-door" factory into a plant manufacturing all kinds of builders' woodwork; and the general, though gradual, alignment of the wood industries with their younger rivals in their attitude toward the public and toward each other.